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Analyzing the Adequacy of Readiness Spending

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PREFACE

The Institute for Defense Analyses (IDA) prepared this document for the Office of the Under Secretary of Defense (Personnel and Readiness) under a task titled "Development of FYDP-Based Readiness Indicators." The objective of the task was to develop FYDP-based tools to improve analyses of the readiness implications of proposed defense programs and budgets. This document presents two such tools.

Daniel L. Cuda, Thomas P. Frazier, and Michael Leonard of IDA were the technical reviewers for this paper.

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EXECUTIVE SUMMARY

Neither the Services nor OSD have tools for quickly understanding the likely readiness implications of prospective future defense programs. The purpose of this paper is to use statistical analysis to develop such tools.

Two kinds of readiness assessment tools were developed. The first allows comparison of proposed readiness funding in future years with readiness funding in past years in which readiness is known to have been high, taking changes in force size into account. We call this our funding benchmark analysis. The second permits estimation of the implications of proposed readiness funding on future readiness levels. This is our readiness prediction analysis.

FUNDING BENCHMARK ANALYSIS

During the period from 1984 until 1997, it is generally believed that the Services maintained a high level of force readiness under a range of conditions. During the 1980s, force structure expanded very modestly. After the end of the Cold War in 1989, a substantial reduction was undertaken. By determining how readiness spending varied with force structure over this period, we sought to provide a way to identify levels of readiness spending adequate for maintaining high readiness in a force of the size proposed for some future years. The analysis has three parts: measuring readiness spending, measuring force size, and relating variations in readiness spending to variations in force size.

Spending Categories

Operations and support funding (including the operations and maintenance and military personnel appropriation categories) was assigned to three spending categories: mission spending, mission-support spending, and other spending. The assignment was made on the basis of program elements. Mission spending is associated with combat units, operational training, and deploying support. Mission-support spending includes those program elements associated with institutional training, base operations related to mission activities and institutional training, and spending on operational headquarters. Other spending, which was felt to have the least direct impact on the readiness of combat

forces, includes medical and environmental expenditures, other administrative expenditures, and spending on space, intelligence, and central communications.

Force Size

For the Navy and Air Force we developed a measure of force size based on the quantity of various kinds of equipment the Services had. Each kind of equipment enters into the force-size measure according to the number of items in the inventory multiplied by a factor that reflects the costs associated with operating that particular kind of ship or aircraft. We call the measure of force size derived from this approach the equipment operating factor (EOF).

For the Army and Marine Corps, force size was measured by the number of active-duty personnel. Since we were not able to get reliable information on equipment inventory for these two Services, active-duty personnel was also used as the force size measure for DoD as a whole.

Analysis

Mission operating and support (O&S) costs were analyzed as a function of force size for the four Services and for DoD as a whole. The estimated equations had the form:

$$\ln(\text{mission O\&S}) = a + b \times \ln(\text{force size}).$$

Table S-1 shows the results of this procedure.

Table S-1. Relationships between Force Size and Mission O&S Spending

	Army	Navy	Air Force	Marine Corps	All DoD
Force size	0.91	1.01	1.08	1.47	1.17
t-value	9.81	7.42	8.98	7.78	19.29
Constant	-1.92	10.19	10.26	-9.14	-5.52
t-value	-1.54	409.52	268.16	-3.98	-6.3
R^2	0.94	0.93	0.96	0.87	0.98
Years used	1984–89; 1993–97	1992–97	1984–89; 1993–97	1984–89; 1993–97	1984–89; 1993–97

Because of the logarithmic form of the equations, the coefficients for force size can be interpreted as the percentage change in spending associated with a one-percent increase in force size. With the exception of the Marine Corps, mission O&S spending changed in proportion to force size. In all cases, the relationship between force size and

mission O&S spending was highly significant and the explanatory power of the equations was quite high.

To the extent possible, spending on contingency operations was excluded from the data. The contingency corrections around the time of Desert Storm were inadequate, so those years were omitted from the analysis. In the case of the Navy, the relationship between spending and force size seemed to change between the 1980s and 1990s. In the 1980s, spending tended to be higher for any given force size. The relationship shown pertained from 1992 through 1997.

Mission support and other O&S spending can be thought of as providing the funds needed by the infrastructure that supports the readiness-related activity funded by mission spending. Therefore, rather than relating spending in these categories directly to force size, we instead related them to mission spending. We hypothesize that there is a lag in the response of mission-support funding. That is, while there is some immediate impact on mission support spending of a change in mission spending, it takes several years for the full impact of the change in mission spending to be felt.

With the exception of other O&S in the Marine Corps, we always found significant relationships between mission O&S and the other spending categories. The hypothesis that there is a lag in the relationships was confirmed in all cases. For mission support O&S, between 37% and 54% of the long-run response takes place in the first year, for other O&S, between 29% and 56% takes place in the first year.

Table S-2 shows the change in spending that can be expected to occur in the long run in response to a one-dollar change in mission O&S spending.

Table S-2. Long-term Spending Changes Associated with Changes in Mission O&S Spending

	Army	Navy	Air Force	Marine Corps	All DoD
Mission-support O&S	0.43	0.38	0.38	0.33	0.40
Other O&S	0.44	0.21	0.33	0.04	0.07

The changes in mission support O&S and (particularly) other O&S spending have been less than proportional to changes in mission O&S spending, and hence less than proportional to changes in force size. Note that at the all-DoD level most of the spending by the defense agencies is captured in other O&S. For several reasons, defense agency spending rose in the 1990s as force size fell. That is probably the explanation for the small estimated relationship between mission O&S and other O&S at the all-DoD level.

To validate the funding-benchmark analysis, we used the estimated relationships displayed in Table S-1 to predict mission O&S spending from 1975 to 1983. This period (especially the early part of it) is generally recognized as one in which readiness was inadequate. It is sometimes called the era of the hollow force. We expected actual spending to be well below the predictions of our model for that period. This expectation was strongly confirmed. Figure S-1 provides an illustration of this.

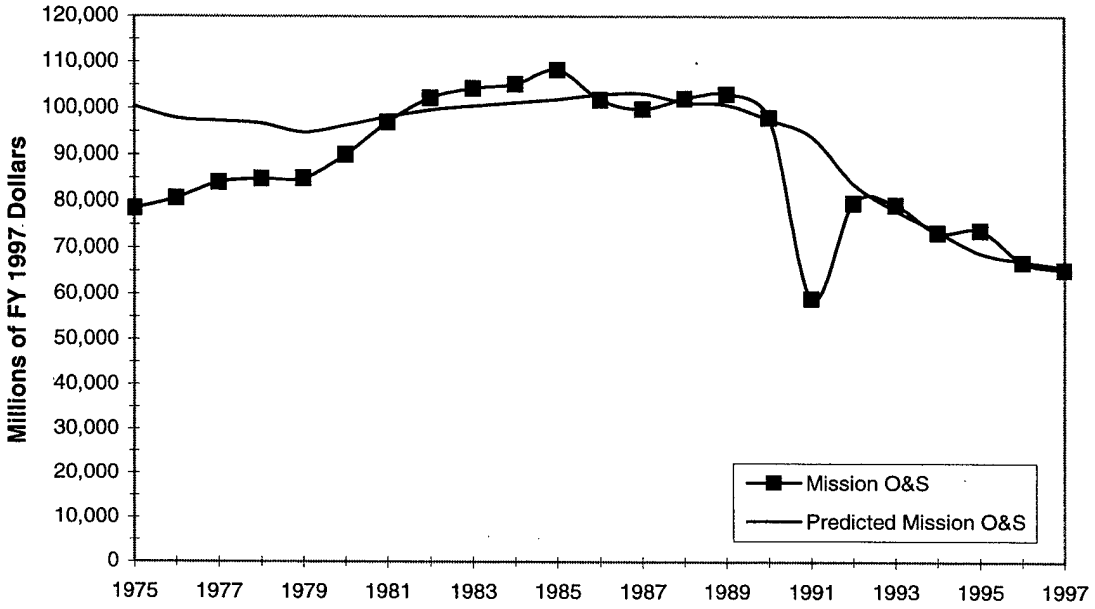

Figure S-1. Predicted and Actual Mission O&S Spending for all DoD, 1975-97

In 1975, the gap between expected and actual mission O&S funding (measured in 1997 dollars) was $21.4 billion, roughly 22% of our estimate of required funding. By 1981, funding was approaching what can be thought of as the required level.[1]

READINESS PREDICTION ANALYSIS

Two methodologies were used to relate variations in spending to variations in readiness. The first builds on the funding benchmark analysis. It hypothesizes that differences between actual and predicted spending (using the relationships discussed above) should predict readiness. We call this difference normalized mission spending, since it normalizes for force size. The second relates readiness directly to spending and

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1 The low-level of apparent spending in 1991 is due to the inappropriately large contingency correction for the Gulf War.

force size. In both cases, we modeled readiness as responding to changes in spending with a lag.

We used data from the Status of Readiness and Training System (SORTS) to develop readiness measures. Under SORTS, each unit is put into one of five categories (C1 to C5). C1 connotes a fully ready unit. C2 implies minor mission degradations. C3 implies serious degradation to at least one mission. C4 means not mission ready. C5 is for units undergoing structural change like getting new equipment or undergoing overhaul. We omitted units reporting C5 from the analysis. We looked at SORTS ratings for combat units only.

SORTS ratings are sometimes criticized for being imprecise and subjective. While there is some validity to these criticisms, SORTS remains the most widely used source of information on the readiness of individual units.

Our analysis strove to relate the percentage of combat units reporting C1 (or C1 and C2) to mission spending, the portion of spending that we expect to be most directly linked to readiness. We looked at both mission O&S spending and mission O&M spending as potential determinants of readiness.

In general, both methodologies found significant relationships between mission spending and readiness at the all-DoD level. Both mission O&S and mission O&M were good predictors of readiness though mission O&M was a little bit better. Changes in spending had a stronger long-term relationship to changes in the percentage of units that was C1 than to the percentage that was C1 or C2.

Tables S-3 and S-4 show the results of our analyses of the relationship between O&M spending and the percentage of combat units reporting C1. Table S-3 is based on the funding benchmark analysis, Table S-4 is based on the direct analysis.

Table S-3. Funding Benchmark Analysis of the Percentage of Units Reporting C1

	Coefficient	*t*-value	Change in Readiness per Billion $ Change in Mission O&M	R^2
Constant	-0.70	—	—	0.82
Normalized mission O&M (lagged 2 years)	0.07	26.32	1.5%	—

Table S-4. Direct Analysis Relating Percentage of Units Reporting C1 to Spending and Force Size

	Coefficient	*t*-value	Carry-over from Last Year	First-Year Change in Readiness per $1 Billion Change in Mission O&M	Long-term Impact of $1 Billion Change
Percentage reporting C1 last year	3.82	29.57	86%	—	—
Mission O&M (FY98)	0.01	4.31	—	0.33%	2.36%
Active (thousands)	-0.0003	-3.51	—	—	—
Constant	1.99	—	—	—	—
$R^2 = 0.92$					

In the funding benchmark analysis, we found that a 1-year lag between changes in normalized spending best predicted changes in readiness. In the direct analysis, a continuous adjustment process provided the best statistical relationship.

The spending variables were highly significant in both equations, and the proportion of variation in the percentage of units reporting C1 status that we were able to explain was quite high. Our best estimate is that a $1 billion change in mission O&M spending per year will increase the proportion of DoD combat units reporting C1 by between 1.5% and 2.4 % over the long run.

FINDINGS AND RECOMMENDATIONS

- During a period when readiness was generally believed to be adequate, there were consistent relationships between readiness-related funding and force size.
- Mission O&S funding varied in rough proportion to force size between 1984 and 1997.
- Mission operations and maintenance (O&M) funding of roughly $22,500 per active-duty military member sustained readiness between 1984 and 1997.
- After adjusting for differences in force size, mission O&S funding between 1975 and 1980 was considerably below 1984-97 levels. This is consistent with the view of the earlier period as the era of the hollow force.
- Mission support O&S funding and other O&S funding varied consistently with mission O&S funding.
- There appear to be quantitatively significant relationships between mission spending and readiness as measured by the percentage of units reporting C1 (and C1 or C2) in SORTS. Relationships like these developed here could be used to assess the potential readiness implications of proposed defense programs.

- It takes several years for the impact of changes in spending on readiness to be fully manifested.
- Relationships of the types developed in this paper could be used to monitor the adequacy of prospective readiness-related funding and to estimate the likely path of future readiness.

I. INTRODUCTION

A. BACKGROUND

Keeping its forces ready is a major goal of the Department of Defense (DoD). Every year when the Services put their programs together, they try to make sure enough money is devoted to maintaining readiness. In its role overseeing the program development process, the Office of the Secretary of Defense (OSD) tries to verify the adequacy of readiness funding.

Readiness is "derived from the ability of each unit to deliver the outputs for which it was designed."[1] Maintaining the readiness of a unit requires that it have enough people and equipment and that training and equipment repair, among other things, be adequately funded. The Status of Readiness and Training System (SORTS) tracks all four of these factors at the unit level.

The connections between funding and readiness at the aggregate Service or DoD levels are not well understood. There are three reasons for this lack of understanding. First, it is difficult to measure readiness, and the measures that are typically used—derived from SORTS—are imperfect. Second, it is difficult to identify the portion of funding that most affects readiness. Not all funds in the program support the ability of units to deliver the outputs they were designed to produce. Spending on the procurement of new equipment is generally not meant to influence readiness. Spending on portions of the defense infrastructure, like installation support and personnel management, affects readiness only indirectly. Third, there have been few efforts to develop quantitative relationships between funding and readiness at aggregate levels.

Both the Services and OSD would benefit from tools that would allow them to more easily understand the readiness implications of proposed or hypothetical defense programs. The risks of under-funding—a force unprepared to carry out its missions—could more easily be avoided. So could the risks of over-funding readiness—unnecessary

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1 *DoD Dictionary of Military Terms* [Online]. Available: http://www.dtic.mil/doctrine/jel/doddict/ [September 15, 1999].

scrimping in the areas of procurement, research and development, and support of the defense infrastructure.

B. OBJECTIVE

The purpose of the analysis documented in this paper is to develop tools for use in analyzing the readiness implications of proposed future defense programs.

C. PLAN OF ANALYSIS

Two kinds of readiness assessment tools were developed. The first allows comparison of proposed readiness funding in future years with readiness funding in past years in which readiness is known to have been high, taking changes in force size into account. We call this our funding benchmark analysis. The second permits estimation of the implications of proposed readiness funding on future readiness levels. This is our readiness prediction analysis.

1. Funding Benchmark Analysis

It is generally believed that the Services maintained a high level of force readiness under a range of conditions during the period from 1984 until 1997. During the 1980s, force structure was expanding modestly. After the end of the Cold War in 1989, a substantial reduction of that structure was undertaken. Our presumption in this analysis is that readiness funding responded appropriately to those variations in force structure, not lagging behind as it expanded or falling too rapidly as it declined. By determining how readiness spending varied with force structure over this period, we seek to provide a way to identify levels of readiness spending adequate for maintaining high readiness in a force of the size proposed for some future years. The analysis has three parts: measuring readiness spending, measuring force size, and relating variations in readiness spending to variations in force size.

We developed measures of readiness spending by placing the operations and support funds associated with individual program elements into one of three categories: mission-related funds, mission-support funds, and other funds. The nature of the categorization is discussed in more detail in Chapter II. An additional measure of readiness spending (which we call either discretionary mission spending or just discretionary spending) was developed by subtracting an estimate of civilian personnel costs from mission-related spending. We felt that since civilian government employees

have to be paid, we might get a more sensitive indicator of how generously the Services intended to fund readiness by subtracting civilian pay from mission-related spending.

Two measures of force size were used: active-duty personnel and a count of the kinds of equipment in the force weighted by a measure of the annual cost of maintaining different kinds of equipment. We term the latter measure the equipment operating factor (EOF). Chapter III explains our approach.

We used regression techniques to relate readiness spending to force size. All four measures of spending were used as dependent variables. From the point of view of understanding the adequacy of readiness spending, the analyses of mission-related spending and discretionary spending deserve the most attention. Chapter IV explains why.

To validate the benchmarks, we compared funding during the mid-to-late 1970s and early 1980s, the era of the so-called hollow force, to what we estimated to be the appropriate funding level based on the force structure of the time. This analysis is presented in Chapter V. We hypothesized that actual funding would be found to be well below the benchmark level.

2. Readiness Prediction Analysis

We used two approaches for this analysis, as explained in Chapter VI. The first drew on the benchmarking analysis. Even during the high-readiness period, mission-related spending was above the benchmark level in some years and below it in others. We hypothesized that higher spending relative to the benchmark would be associated with higher readiness, measured by the fraction of combat units in the highest (or two highest) readiness categories according to SORTS. The second directly related the distribution of SORTS ratings to mission-related readiness spending and force size. Both approaches took account of the possibility that changes in spending have a delayed effect on readiness.

D. SUMMARY OF RESULTS

The results of our analyses are summarized below.

- Mission-related spending (and discretionary spending) varied in rough proportion to force size during the high-readiness period.
- Mission-support and other spending were not quite as sensitive to changes in force size.

- Correcting for changes in force structure, readiness spending during the hollow-force period was dramatically below the levels that pertained from 1984 to 1997.
- Force readiness, as reflected in the SORTS ratings of combat units, is significantly related to mission-related spending.

II. MEASURING READINESS SPENDING

A. OVERVIEW OF THE FUTURE YEARS DEFENSE PROGRAM AND FUNDING FOR READINESS

In this chapter we describe how we developed time-series data on readiness spending. The source of the data was the Future Years Defense Program (FYDP). It is the basic structure used to categorize spending in the Department of Defense. It summarizes the defense program for a 6-year period by program element (PE). Each PE is assigned to one of the major force programs (MFPs) listed in Table II-1.

Table II-1. Major Force Programs

MFP	Title
1	Strategic Forces
2	General Purpose Forces
3	Intelligence and Communications
4	Mobility Forces
5	Guard and Reserve Forces
6	Research and Development
7	Central Supply and Maintenance
8	Training, Medical, Other General Personnel Activities
9	Administration and Associated Activities
10	Support of Other Nations
11	Special Operations Forces

Spending directly related to readiness is found largely in MFPs 1, 2, 4, and 5. Some depot maintenance spending in MFP 7 might also be considered directly related to readiness. The MFP structure does not by itself provide a complete framework for categorizing readiness spending. Part of the money in MFPs 1, 2, 4, and 5 is related to the procurement of forces rather than their readiness. Procurement funding can be differentiated from readiness-related funding by looking at the appropriation breakout within program elements. We considered only operations and maintenance (O&M) appropriations plus military personnel funds to be associated with readiness. These are referred to as operating and support (O&S) costs.

O&S funds found in programs 1, 2, 4, 5, and 7 might provide a reasonable measure of funding for readiness, but we felt further adjustments were necessary. Some of the program elements in these MFPs are associated with management headquarters and other infrastructure-related activities that have only a marginal connection to the readiness of forces. We saw no easy way around this problem. We went through the entire FYDP and categorized program elements into three spending categories: mission-related, mission support, and other. The nature of this categorization is discussed in Section C of this chapter.

B. DATA ADJUSTMENTS

1. Adjustment for Changes in Accounting Practice

Once the program elements in the current FYDP are categorized into spending categories, it would seem to be a simple matter to use historical FYDP information to develop time-series data on spending by category. Unfortunately, it is not so simple.

Over the years, rules for assigning some kinds of spending to program elements have changed. These changes included:

- Retired pay accrual shifted from a separate account to military pay.
- Funding of spares and supply support costs shifted from logistics accounts in MFP 7 to customer accounts in MFP 1, 2, 4, or 5.
- Equipment modification installation costs shifted from centrally managed O&M accounts to procurement funding in the customers' accounts.
- Air Force depot maintenance shifted from centrally funded logistics to operational customers.
- First-destination transportation (the delivery of new equipment) shifted from O&M to procurement.
- Subsistence-in-kind shifted from military personnel to O&M and back to military personnel.
- Medical costs shifted from the Services to OSD.
- Special operations costs shifted from the Services to the Special Operations Command with the creation of MFP 11.

A procedure was developed for adjusting historical FYDP data so that the historical assignment of funds to program elements and appropriation categories approximates what it would have been if today's accounting rules had pertained in the

past.[1] Figure II-1 shows the impact the adjustments had on the measurement of mission-related funding between FY 1975 and FY 1997.

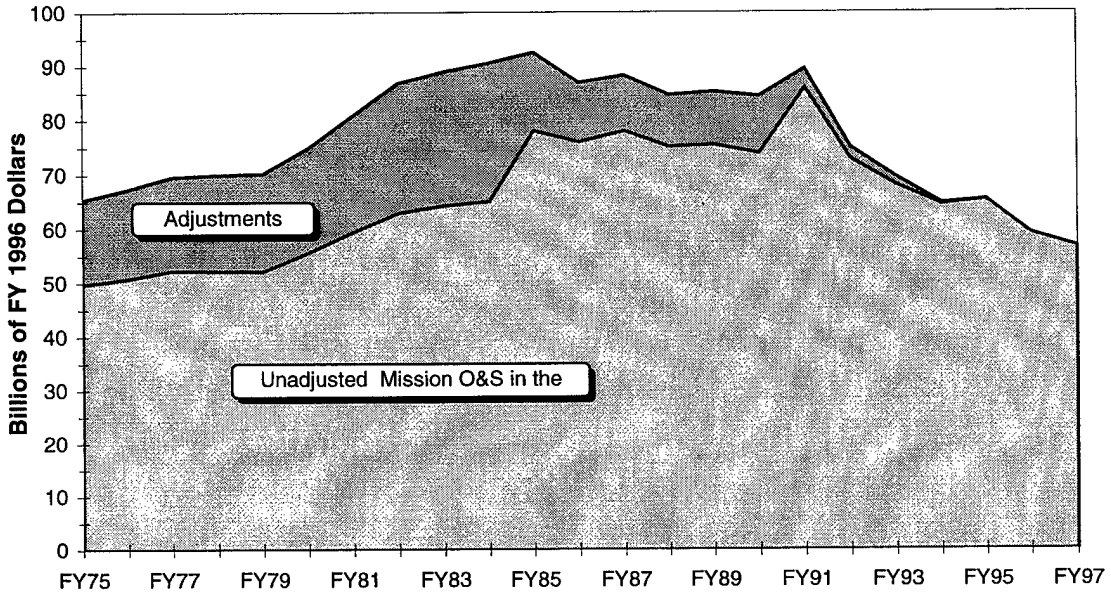

Figure II-1. Impact of Accounting Changes on Mission O&S

When FY 1997 accounting rules are used, we see mission O&S was far higher during the late 1970s and the 1980s than is apparent from looking at unadjusted historical FYDP data. Correcting for these accounting changes should allow us to estimate the relationship between consistently measured readiness funding and force size.

2. Adjustment for Spending on Contingencies

Between 1990 and 1997, the United States was involved in many contingency operations. These include activity in Somalia, Haiti, Iraq, and Bosnia. These missions required funding above what would have been needed to keep forces ready. So that we would not overstate the level of O&S funding associated with the maintenance of readiness during this period, we attempted to subtract contingency costs out of the funding data.

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1 See James L. Wilson, Timothy J. Graves, John A. Lobi, and Ronald E. Porten, "Normalizing the Future Years Defense Program for Funding Policy Changes," Paper P-3194, Institute for Defense Analyses, January 1997.

The Defense Finance and Accounting Service (DFAS) prepares monthly reports on the cost of contingency operations, as reported to DFAS by the Services and defense agencies. These reports identify costs separately for each operation and for each participating Service and defense agency. Costs are also identified as Active, Guard, or Reserve and divided between Military Personnel, Operations and Maintenance, and All Other Appropriations. The costs listed are the incremental costs of the operation. For example, the costs would include the additional cost of hazard pay for personnel involved in the operation but not their base pay. The reports also list how much of these costs have been offset by supplemental funds or reprogramming funds already in the budget and how much had to be absorbed by the Service. The costs for contingency operations are available back to 1990.

We adjusted the total amount of funding available to a Service for the costs of these contingency operations by subtracting the total cost of the contingency operation from the budgeted amount for that Service. We used the total cost rather than the supplemental and reprogrammed funds because we wanted to remove any money used in contingency operations that had been initially targeted toward maintaining the peacetime readiness of forces. Often the costs of the operation absorbed by the Service come from such areas as the training budget. We would expect that absorbing large costs from contingency operations would harm the readiness of the troops by reducing the resources available to them.

Unfortunately, the costs were not allocated to program elements or divided into our three spending categories of mission, mission support, and other. We felt that the cost of contingency operations would be tied most to mission and, to a lesser extent, to mission support activities. Consequently, we divided the total contingency cost so that 90% came from mission spending and 10% from mission support spending.

While these corrections made sense in most years, for the Desert Storm years of 1991 and 1992, the corrections were much too large for some Services and much too small for others. We found that the contingency correction in 1991 for the Army was so large that when we subtracted it from mission O&M funding, negative funding resulted. For the Marine Corps, even after subtracting the contingency correction, there remained a large spike in the data for 1991 and 1992. Because we could not determine why these anomalies in the data occurred, we dropped those years from our statistical analyses.

C. SPENDING CATEGORIES

The development of spending categories grew out of the existing mapping of program elements into infrastructure categories.[2] That mapping identifies PEs associated with combat units, operational training, and deploying support. All of those were included in the mission spending category. We also included two infrastructure sub-areas, maintenance activities and logistics management (which includes inventory control-point operations), in the mission spending category because we felt they have a direct link to readiness.

Mission-support spending includes those program elements associated with institutional training, base operations related to mission activities and institutional training, and spending on operational headquarters.

Other spending, which we felt had the least direct impact on the readiness of combat forces, includes medical and environmental expenditures, other administrative expenditures, and spending on space, intelligence, and central communications. We do not mean to imply that intelligence expenditures, for example, do not contribute to defense capability in a critical and immediate fashion, just that we do not expect them to be closely related to the reported readiness of combat forces.

D. TOOTH-TO-TAIL RATIOS

Before trying to understand changes in the three categories of O&S spending in response to changes in force size, we examined how the categories changed over time relative to each other.

We began by examining changes in spending by category since 1975. This is shown at the DoD level in Figure II-2. Notice that mission O&S is the largest of the categories, but that the difference is not as great as it used to be. Other O&S costs in particular have risen over the past two decades. We examine the relative shifts among the categories by tracking what we call the tooth-to-tail ratios for the Services and for DoD as a whole.

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2 This taxonomy is described in Timothy J. Graves, David Drake, Pamela W. Forsyth, and James L. Wilson, "A Reference Manual of Defense Mission Categories, Infrastructure Categories, and Program Elements," Paper P-3113, Institute for Defense Analyses, June 1995. Appendix G shows the mapping of program elements into infrastructure categories.

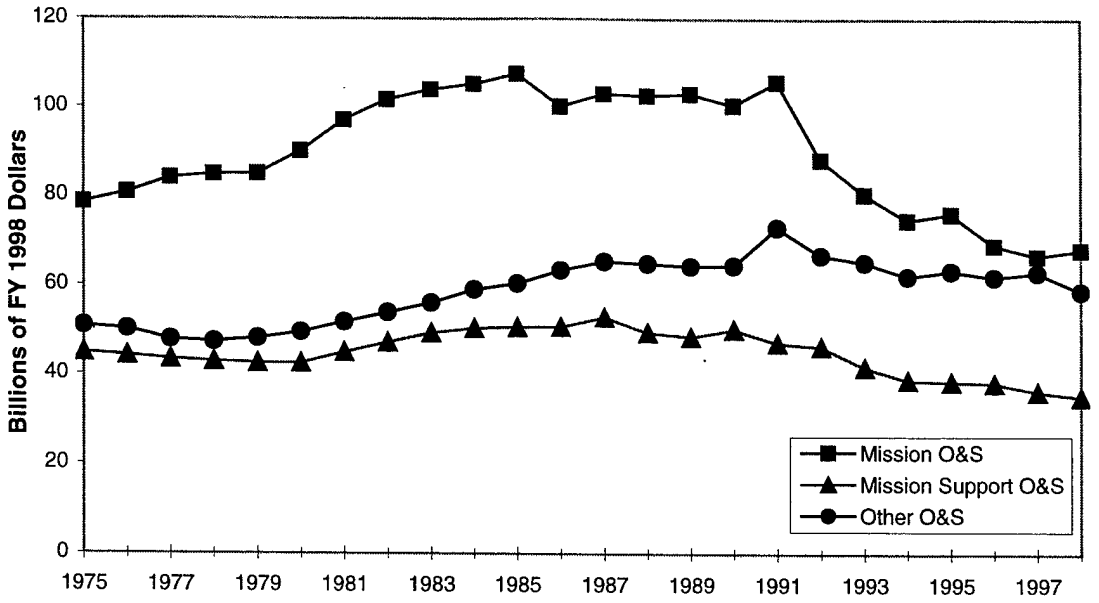

Figure II-2. Trends in DoD O&S Spending by Category

We defined the tooth-to-tail ratio to be mission O&S funding divided by mission support O&S plus other O&S. A higher tooth-to-tail ratio means that a higher proportion of O&S funding is going to activities that are most closely related to combat—the tooth. Likewise, a lower tooth-to-tail ratio means that more funding is going to those activities that directly or indirectly support combat units—the tail. For each Service and for all DoD, we looked at how these ratios changed over time. In all cases, the Desert Storm–affected years of 1991 and 1992 were dropped.

Our purpose in this analysis is not to imply that mission O&S spending is better than other kinds of O&S spending. It is merely to examine how the composition of operating and support expenditures has changed over time. A fall in the tooth-to-tail ratio may just mean that mission-related spending is more responsive to changes in force size than mission support and other spending. This issue is addressed in Chapter IV. It may also mean that the nature of warfare has changed in ways that emphasize the importance of things like space, intelligence, and communications, which make up a large part of other O&S spending.

1. Army

The tooth-to-tail ratio for the Army (Figure II-3) peaked in 1989 at 1.1. Beginning in that year, the ratio fell consistently until 1996, when it reached a low of 0.83; this is

below the value of 0.93 observed in 1975. This means that mission spending has been cut more than mission support and other funding since 1989. After 1996, the ratio recovers somewhat.

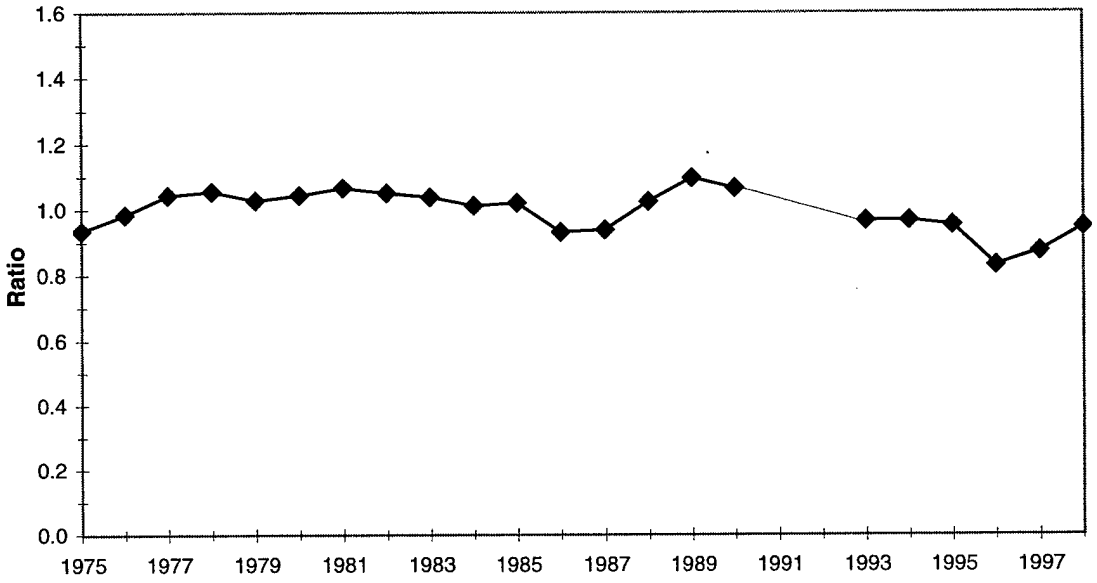

Figure II-3. Army Tooth-to-Tail Ratio

2. Navy

The tooth-to-tail ratio for the Navy (Figure II-4) peaked at 1.37 in 1985 and has exhibited a general downward trend since that time. It stood at 1.25 in 1989, but fell to 1.02 by 1996. This is lower than the levels seen during the hollow years when the ratio never fell below 1.14. Like the Army, this means that mission spending has been cut more than mission support and other spending during the reduction.

3. Air Force

For the Air Force, the tooth-to-tail ratio (Figure II-5) actually peaked in 1982 at 1.02. There has been a general downward trend since then. In 1989 the ratio was 0.87; by 1997 it was 0.62. This is below the value of 0.7 seen in 1975. This means that mission spending fell more than mission support and other spending.

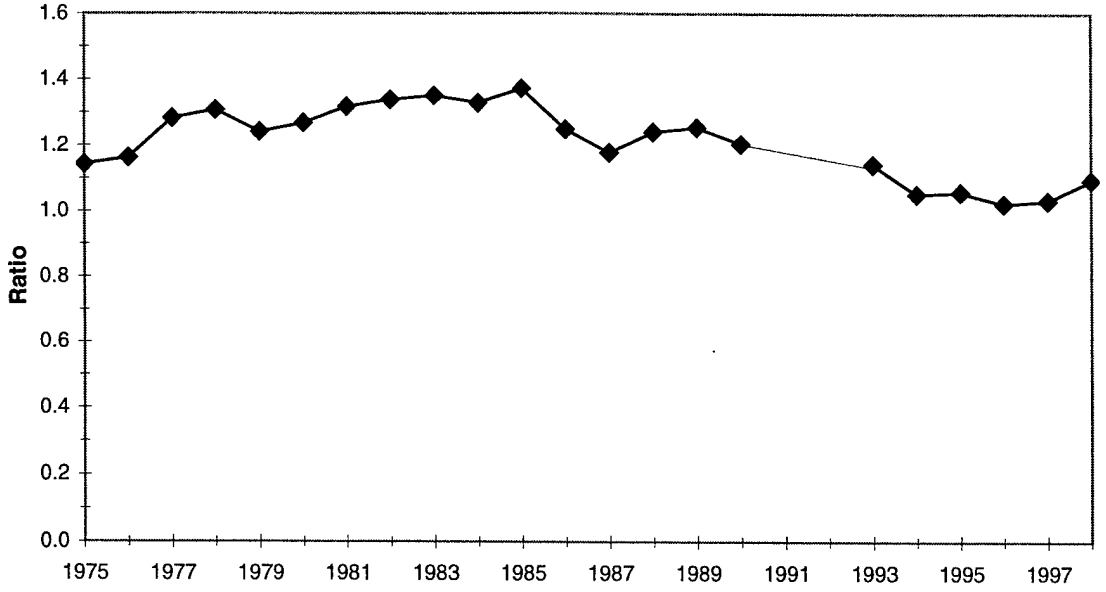

Figure II-4. Navy Tooth-to-Tail Ratio

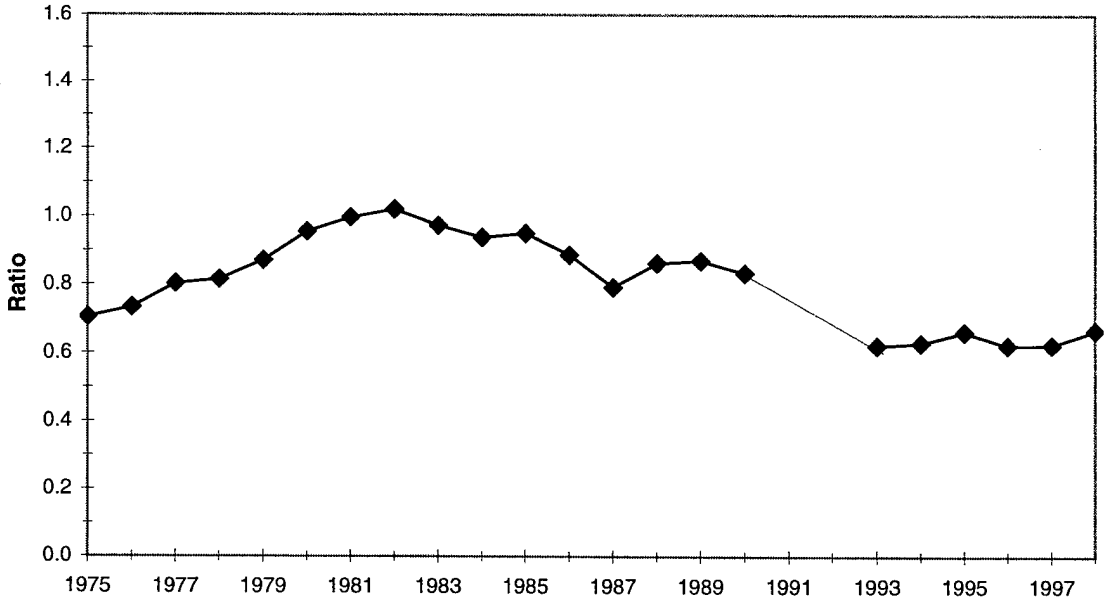

Figure II-5. Air Force Tooth-to-Tail Ratio

4. Marine Corps

The tooth-to-tail ratio for the Marine Corps (Figure II-6) peaked at 1.53 in 1984. In 1989 it still stood at 1.4 then fell to 1.17 by 1996. This was below the 1.27 seen in 1975. Again, this means that mission spending was cut more than mission support and other spending since 1989.

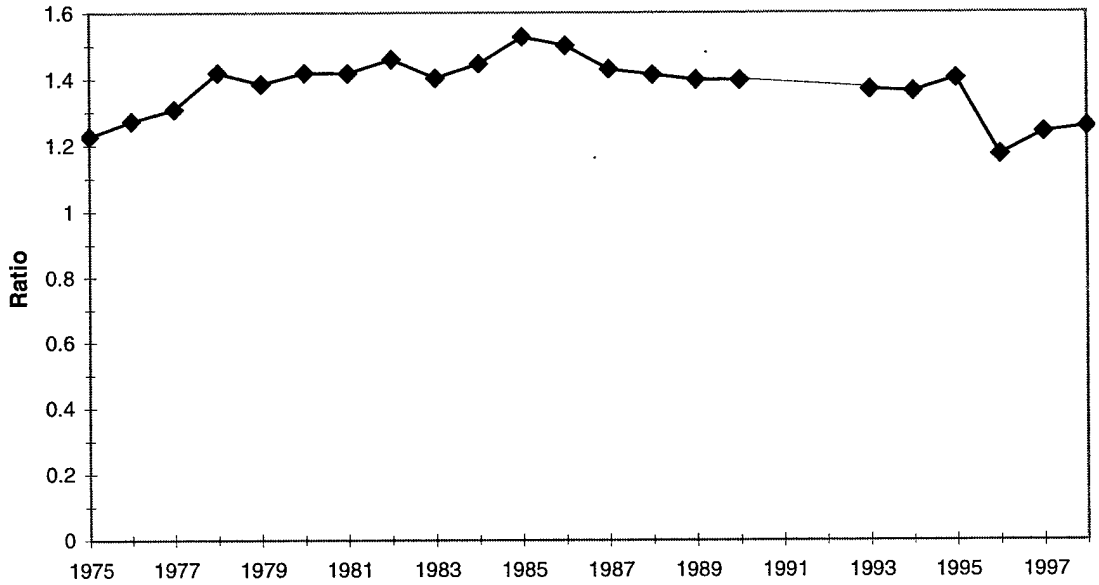

Figure II-6. Marine Corps Tooth-to-Tail Ratio

5. All DoD

The tooth-to-tail ratio for all DoD (the four Services plus the defense agencies) peaked in 1982 at 1.01 (Figure II-7). Since that time, it has demonstrated a general downward trend. In 1989, it was still as high as 0.88 but fell to 0.67 in 1997. This is lower than the value of 0.82 seen in 1975. This decrease shows that mission spending has been cut more than mission support and other spending during the reduction.

6. Summary

With the exception of the Army, tooth-to-tail ratios have been falling throughout DoD. This may be because there are larger fixed components to mission support and other spending than there are for mission spending. It may also reflect an increase in the importance attributed to some kinds of other O&S expenditures.

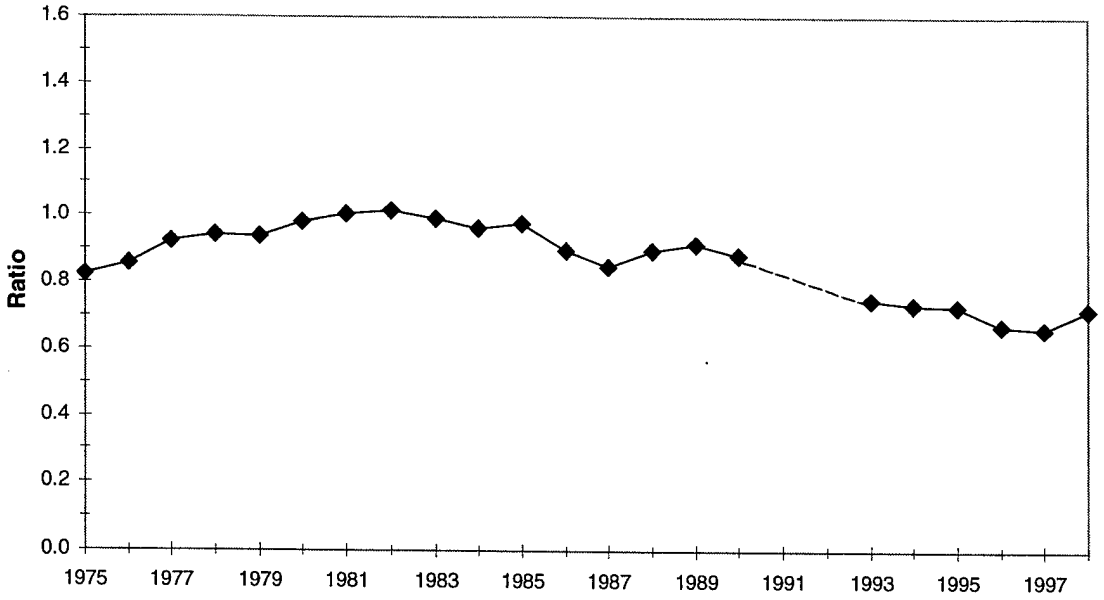

Figure II-7. All DoD Tooth-to-Tail Ratio

III. MEASURING FORCE SIZE

A. ALTERNATIVE APPROACHES

We considered the following four ways of measuring the size of a military force, either for an individual Service or for DoD as a whole:

- *A count of particular kinds of units or equipment.* Examples are number of divisions, number of wings, number of ships, and number of aircraft. These measures have two problems. Not all the units or kinds of equipment in a group are the same. For example, bombers cost more to operate than fighters, and heavy divisions, more than light divisions. Changes in the nature of forces can lead to changes in funding requirements even if the number of units stays the same. In addition, different measures cannot be added across Services to get a DoD total. Even within a Service (say the Navy) one cannot add ships and aircraft wings.
- *A count of different kinds of equipment weighted by the procurement cost of each (capital asset value).* Introducing money, a requirement for which all weapons systems and units have in common, allows disparate units and equipment types to be compared along the same yardstick. It may not, however, be the most relevant yardstick. The O&S requirements for different kinds of equipment may not be proportional to their procurement cost.
- *A count of different kinds of equipment weighted by the annual operating and support cost of each.* The Services have developed cost factors that reflect the O&S costs associated with particular kinds of ships, aircraft and other weapon systems. It seems appropriate to use these factors to develop an aggregate indicator of the requirement for mission O&S funding. We have termed the measure of force size derived from this approach the equipment operating factor (EOF).
- *The number of personnel.* With this measure, perhaps the oldest indicator of force size, one could use active personnel, total uniformed personnel, or the sum of civilian and uniformed personnel.

We tried to develop equipment-based analyses for all the Services, but were not able to get reliable equipment inventory information for the Army and Marine Corps. Therefore, we used the EOF as the measure of force size for the Navy and Air Force and the number of active personnel as the measure for the Army and Marine Corps. Because

the Air Force and Navy are more equipment-intensive operations and the Army and Marine Corps more personnel-intensive, we felt this was appropriate.

B. EQUIPMENT-BASED MEASURES

1. Navy

The EOF for the Navy was developed using information from the Navy's Visibility and Management of Operating and Support Costs (VAMOSC) data system. For ships, factors were developed by averaging data from FY 1984 to FY 1993 at the ship-class level. The factors are shown in Table III-1.

Table III-1. Annual O&S Factors for Navy Ships

Ship Type	Class	Cost Factor	Ship Type	Class	Cost Factor
SSBN	616	14.0	AD	41	10.5
SSBN	627	11.8	SSN	594	14.2
SSBN	640	11.7	SSN	597	14.8
SSN	608	13.6	SSN	637	14.2
AS	31	17.5	SSN	671	14.6
AS	33	20.5	SSN	685	16.5
CV	41	83.9	SSN	688	14.8
CV	59	80.0	SSN	598	12.6
CV	63	91.5	SSN	608	13.6
CV	67	75.1	SSN	640	16.9
CVN	65	72.5	AS	36	16.7
CVN	68	64.0	AS	39	16.5
CG	16	13.4	AS	31	17.5
CG	26	14.4	AS	33	20.5
CG	47	13.1	LCC	19	15.2
CGN	9	31.1	LHA	1	30.5
CGN	25	29.2	LPD	4	11.9
CGN	35	29.8	LSD	36	8.9
CGN	38	31.0	LSD	41	6.6
CGN	36	32.5	LSD	41	6.6
DDG	2	11.9	LST	1179	7.5
DDG	51	9.1	AR	5	9.8
DDG	993	12.6	ARS	38	2.3
DDG	963	12.5	ARS	50	2.4
FFG	1	8.1	ATF	148	0.7
FFG	7	6.8	ATS	1	6.1
AD	14	9.9	ASR	7	4.2
AD	37	12.7	ASR	21	8.5

VAMOSC data were also used to develop factors for Navy aircraft. They are shown in Table III-2. For both ships and aircraft, we followed procedures similar to those documented by Henry Eskew and Arnold Perez of the Center for Naval Analyses.[1]

Table III-2. Annual O&S Factors for Navy Aircraft

Aircraft Type	Factor	Aircraft Type	Factor	Aircraft Type	Factor
A-4E	0.44	ES-3A	1.20	LC-130R	1.10
A-4F	0.48	EA-6A	0.97	LC-130F	1.06
A-4M	0.35	EA-6B	1.69	UH-1N	0.30
A-6	1.18	EA-7L	0.63	UH-3A	0.26
A-6E	1.18	EC-130Q	3.17	UH-3H	0.25
A-7E	0.57	E-6A	0.82	UH-46D	0.55
F-5F	1.46	EP-3A	0.91	CH-46E	0.55
F-5E	1.05	EP-3B	0.91	CH-46D	0.55
F-14A	1.32	EP-3E	1.77	CH-53E	0.85
F-14D	1.32	EP-3J	1.77	SH-2F	0.66
F-16N	1.13	E-2B	0.66	SH-2G	0.62
F-14B	1.32	E-2C	0.66	SH-3D	0.49
F-4S	0.79	UC-12B	0.54	SH-3G	0.48
F/A-18	0.82	UC-12F	0.50	SH-3H	0.62
P-3A	0.53	UP-3A	0.88	SH-60B	0.59
P-3B	0.87	UP-3B	0.88	SH-60 ()	0.46
P-3C	1.08	US-3A	1.20	MH-53E	0.72
S-3A	0.89	VP-3A	0.51	HH-1N	0.30
S-3B	1.20	C-130F	1.06	HH-46A	0.57
TC-130C	0.86	CT-39E	0.56	HH-46D	0.57
TC-130Q	0.88	CT-39G	0.56	HH-60A	0.33
TF-16N	1.22	C-1A	0.70	AH-1J	0.23
T-2C	0.79	C-2A	0.82	AH-1W	0.31
TA-4J	0.77	C-9B	2.07	VH-3A	0.71
TA-7C	0.37	KA-6D	0.90	RH-53D	0.8
EA-3B	1.48	KC-130F	1.18		

We calculated the factors for both ships and aircraft in millions of FY 1994 dollars. However, we did not use the factors to directly calculate mission O&S requirements. Rather, we used them to approximate the relative impact of different kinds of equipment on the need for readiness-related funds.

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1 Henry L. Eskew and Arnold W. Perez, "The Revised Fiscal Requirements Model," CRM-93-158, Center for Naval Analyses, August 1993.

We then applied the factors to the annual inventories of the various kinds of Navy equipment to develop a time-series of Navy-wide EOF data.

2. Air Force

Operating and support cost factors for Air Force equipment were taken from the Air Force's SABLE model. The factors that were used are displayed in Table III-3.

Table III-3. Annual O&S Factors for Air Force Equipment

Equipment Type	Factor	Equipment Type	Factor
A-10	0.82	F-117A	5.61
A-37	0.13	F-22	1.19
B-52	4.21	RF-4	0.84
FB-111	3.59	F-106	1.20
B-1	4.98	F-111	3.43
B-2	10.58	F-16	0.86
EF-111A	2.74	CH-3	0.14
C-17	2.83	CH-53	1.02
C-20	2.23	HH-3	0.22
C-22	1.77	HH-53	0.86
C-5	4.41	TH-1	0.27
C-9	1.42	UH-60A	0.74
C-130	1.47	O-2	0.11
C-135	3.74	OV-10	0.32
C-141	3.95	E-3	5.42
AC-130	2.82	E-4	17.62
C-32A	0.61	E-8	0.48
EC-130	1.59	E-9	0.02
EC-135	2.54	Advanced	0.09
HC-130	1.80	Cruise Missile	
KC-135	1.30	LGM-30F	0.78
KC-10A	4.70	Minuteman II	
RC-135	3.69	LGM-30G	0.78
C-137	1.52	Minuteman III	
C-140	1.35	LGM-118A	1.73
F-4	1.59	Peacekeeper	
F-5	0.95	Air-Launched	0.02
F-15	1.57	Cruise Missile	

3. EOF Trends

We produced EOF time series for both the Air Force and Navy by using the factors in Tables III-1, III-2, and III-3 to calculate the weighted sums of equipment

inventories for every year in our analysis. The time series were then normalized so that they equaled 1.0 in 1989.

The weights used for particular systems (ships or aircraft) did not vary from year to year nor did they reflect variations over time in the operating tempo of equipment. There were two reasons for this. First, we wanted a measure of force size based on operating cost factors that reflected a level of operating tempo adequate to maintain high training readiness. Second, we were not able to get enough information on annual variations in operating tempo to take them into account.

Figure III-1 shows the EOF trends for both Services from 1976 to 1997.

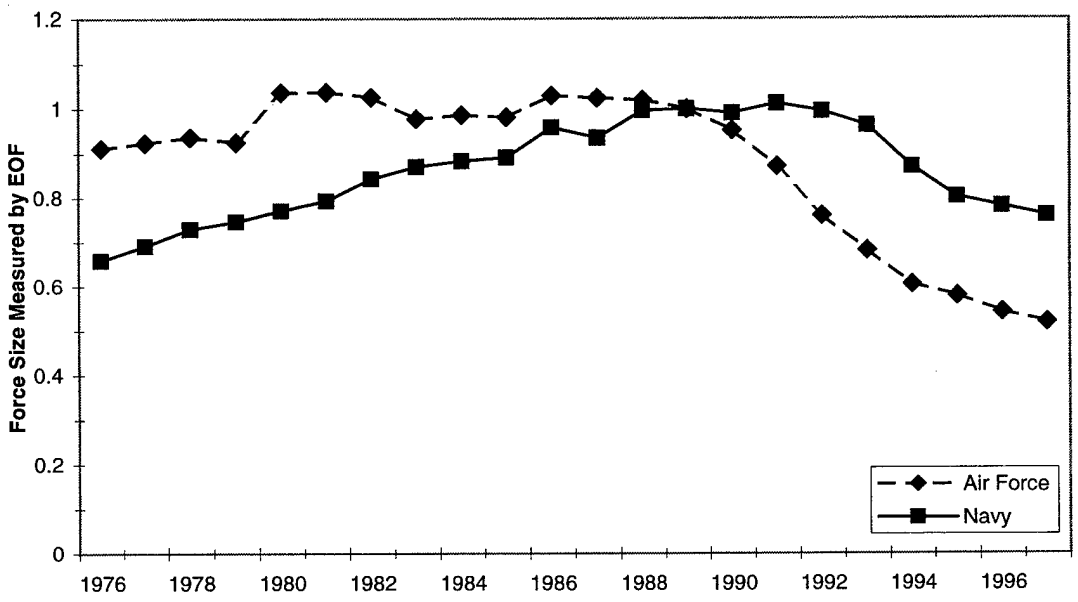

Figure III-1. EOF Trends for the Air Force and Navy

C. PERSONNEL-BASED MEASURES

For the Army and the Marine Corps, force size was measured by the average number of active-duty personnel on board during a year. We tried other measures, such as active plus reserve personnel, but they were not as successful in explaining variations in mission readiness spending. We also considered using mission personnel as the measure of force size because it should better capture the need of combat forces for readiness-related funding. We stuck with total active personnel because it is a more conventional indicator. Also, when considering the budgetary implications of future force size changes,

it is much easier to get information about the proposed level of total military personnel than of mission military personnel.

Figures III-2 and III-3 show the trends in active-duty personnel for the Army and Marine Corps respectively.

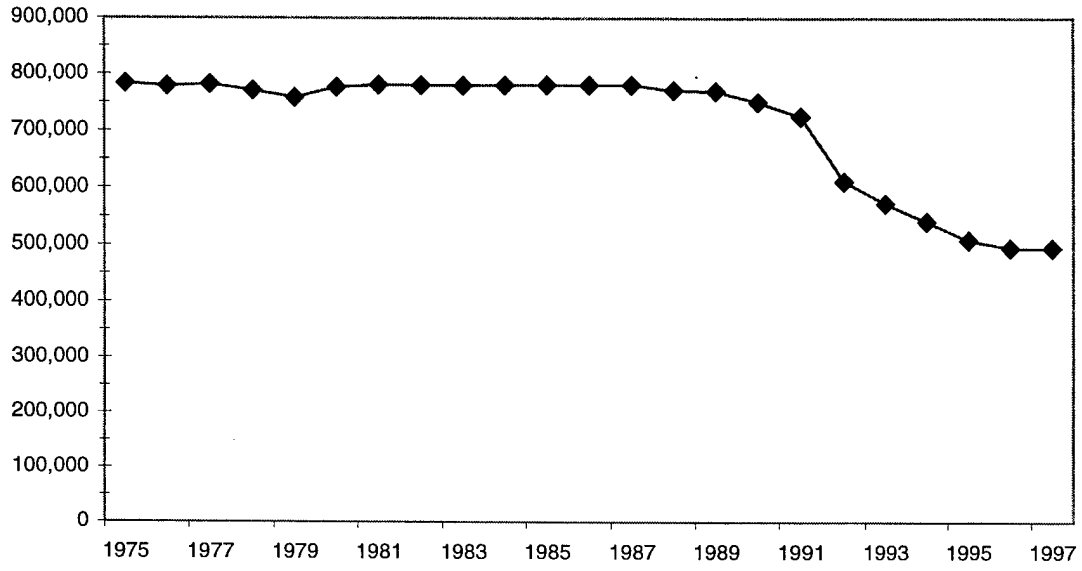

Figure III-2. Trend in Active Army Personnel

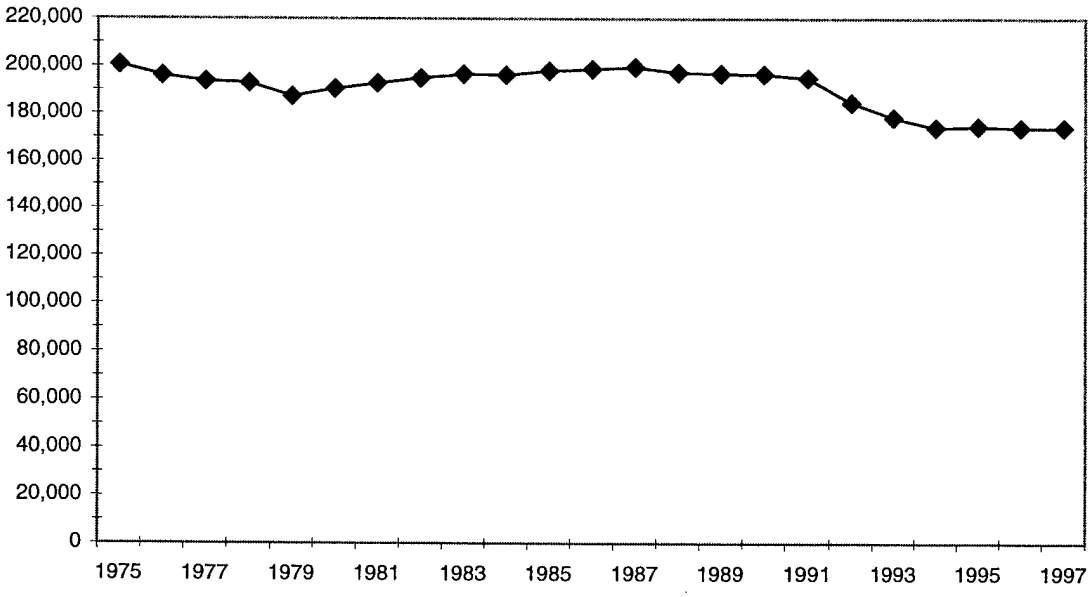

Figure III-3. Trend in Active Marine Corps Personnel

Since we did not use EOF to measure force size for the Army or Marine Corps, it was necessary to use personnel as the force size measure for DoD as a whole. Figure III-4 displays this trend.

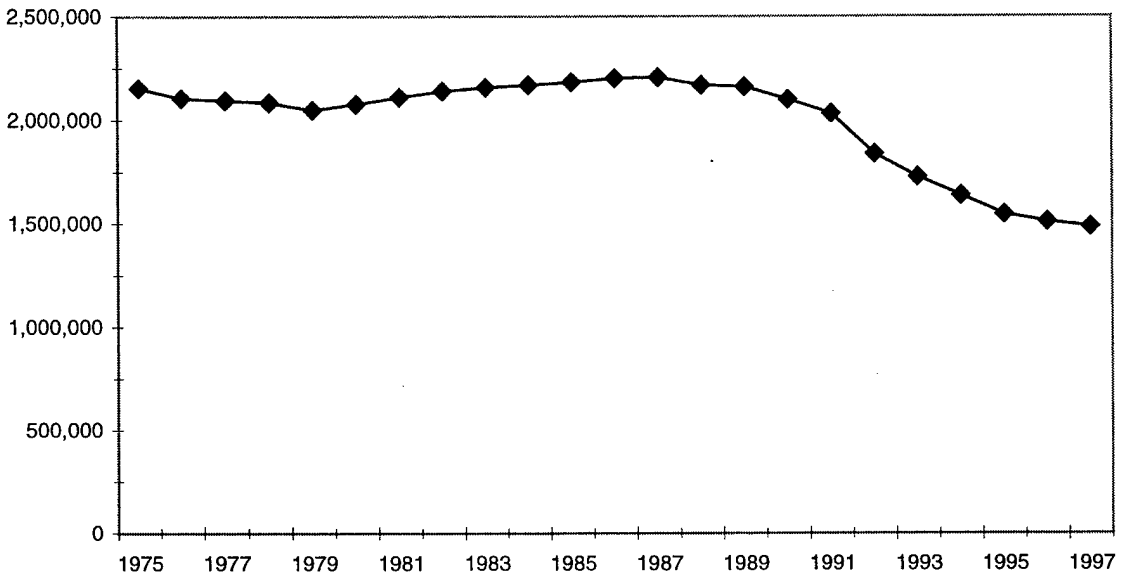

Figure III-4. Trend in Total DoD Active Personnel

D. SUMMARY OF TRENDS IN FORCE SIZE

Figure III-5 summarizes the force size data we used in our analyses of mission O&S spending and readiness. In all cases, force size was normalized to equal 1.0 in 1989, a year chosen to mark the end of the Cold War and the start of the serious reductions in defense forces.

The trends for the Army, Air Force, Marine Corps, and DoD have the same shape, a constant force size through the 1980s and a drop following 1989. The Marine Corps suffered a smaller decline than did the Army and Air Force. The Navy followed a different pattern; it grew through the 1980s and the growth did not start to reverse until 1992. This was because of major Navy procurement during the 1980s. The Navy's active personnel trend during the 1980s looked much like the force size measures for the other Services, showing only a small increase.

In the next chapter, we turn to an examination of how categories of O&S funding varied with force size.

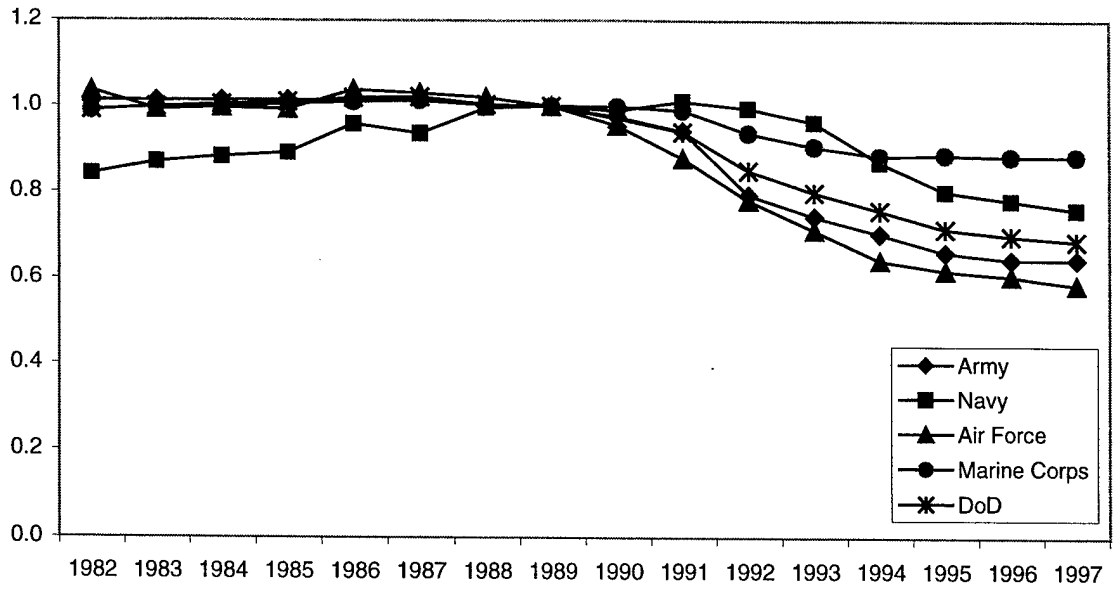

Figure III-5. Trends in Force Size

IV. RELATING READINESS SPENDING TO FORCE SIZE

Our goal was to develop tools that will allow DoD to assess whether proposed funding levels are adequate to maintain readiness. Our first step was to divide O&S funding into three categories: mission spending, mission support spending, and other spending. Mission spending is most closely associated with readiness. It includes combat forces, direct training, deploying support, and depot maintenance. Mission support spending is less tied to readiness. It includes such things as institutional training, base operations, and operational headquarters. Other spending is least tied to readiness and includes all spending not included in the previous two categories, such as environmental, medical, central communications, space, and intelligence.

For the period 1984 to 1997, we related these three categories of O&S spending to the measures of force size discussed in the previous chapter (i.e., EOF for the Navy and Air Force and active-duty personnel for the Army, Marine Corps, and DoD). Only the years 1984 through 1997 were used because there is general agreement that readiness was adequate in these years. Thus, we concluded spending in these years was sufficient to maintain readiness. Therefore, our regression analysis derives a relationship between force size and the level of funding required to maintain adequate readiness. One implication of this analysis is that for the period from the mid-1970s to the early 1980s, when readiness was felt to be inadequate, our model should predict higher levels of O&S funding than actually occurred. This implication is explored in Chapter V.

A. MISSION SPENDING

Mission O&S spending was related directly to force size. The analysis was performed for each Service and for DoD as a whole (the Services plus defense agencies). The estimated equations had the form:

$$\ln(\text{mission O\&S}) = a + b \times \ln(\text{force size})$$

The log-log form was used in part because it has the advantage that the coefficients have readily understandable interpretations. The coefficient is the percentage change in the dependent variable that can be expected from a given change in the

independent variable. For example, in the equation above, a 1% change in force size would result in a *b*% change in mission O&S spending.

1. Army

For the Army, Figure IV-1 shows the levels of active personnel, mission O&S spending, mission support O&S spending, and other O&S spending for the period 1984–97. Each has been normalized so that its value is equal to one for 1989.

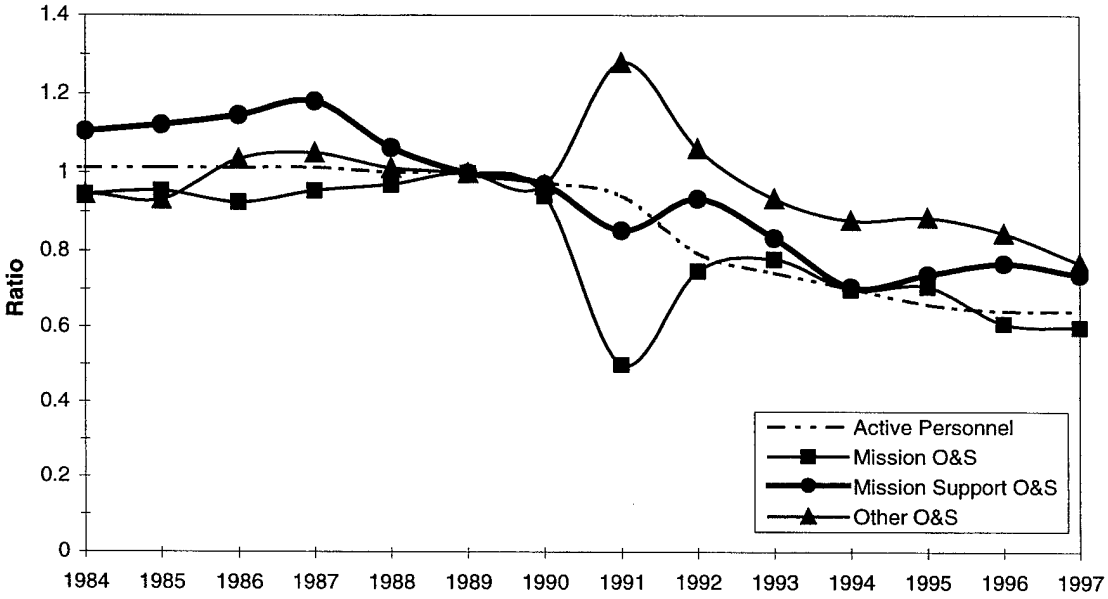

Figure IV-1. Normalized Active Personnel and O&S Spending by Category for the Army

Both active personnel and mission O&S show a downward trend since 1989. Our estimated relationship between the two is presented in Table IV-1.

We dropped the years 1990–92 from the regression because the contingency adjustment for Desert Storm was too large. The fit of this equation as measured by the R^2 is quite good. It says that our model explains 94% of the variation in mission O&S spending over this time period. The personnel coefficient is very significant. It indicates that a 10% reduction in the number of active-duty personnel would result in a 9.1% reduction in mission O&S spending. Thus, the mission component of total O&S funding fell nearly proportionately with the reduction in the number of active-duty personnel.

Figure IV-2 shows the predicted and actual spending for the Army from 1982 to 1998. Lines one standard deviation above and below the predicted values are also shown

on the graph. This band gives an idea of the normal variations in spending that would be expected to occur.

Table IV-1. Relationship Between Force Size and Mission O&S Spending for the Army

Explanatory Variable	Coefficients
Personnel	0.91
t-value	9.81
Constant	-1.92
t-value	-1.54
R^2	0.94
Years used	1984–89; 1993–97

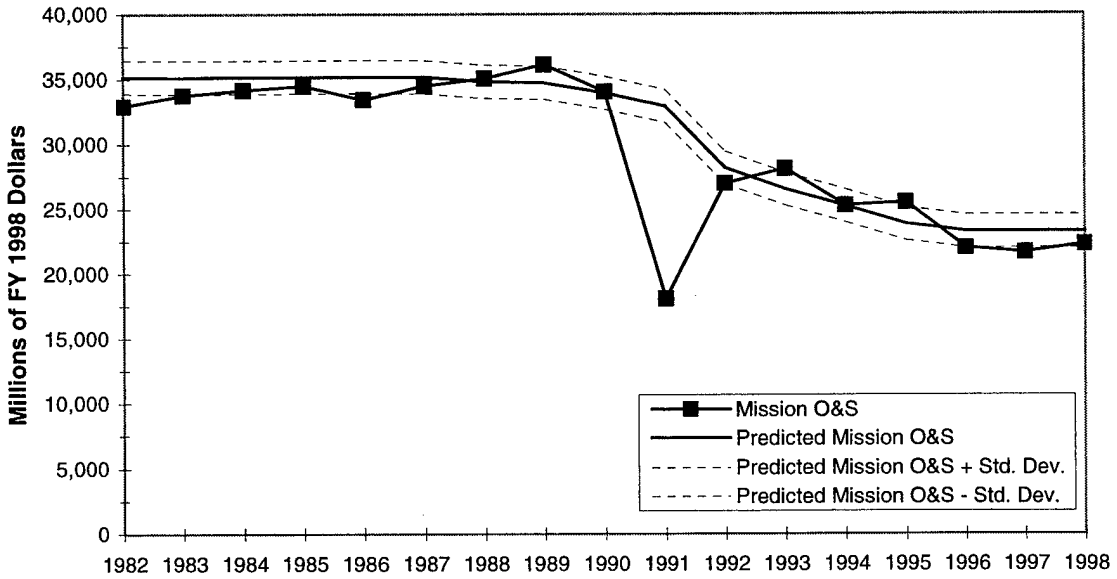

Figure IV-2. Predicted and Actual Mission O&S Spending for the Army

2. Navy

Figure IV-3 shows the levels of mission spending, mission support spending, other spending, and EOF for the Navy for 1984–97, normalized so that the value for 1989 is equal to one.

Table IV-2 presents the results of the regression analysis relating mission O&S to force size. Only the years from 1992–97 were used in the regression. Attempts to use

earlier years yielded a poor fit to the equation and unrealistic coefficients on the explanatory variable. It appears that the relationship between force size and mission O&S changed during the observation period. Before 1989, normalized mission O&S was above its 1989 level while EOF was below the 1989 level. It appears that the Navy was able to maintain readiness more cheaply for a given force size in the 1990s than it could in the 1980s.

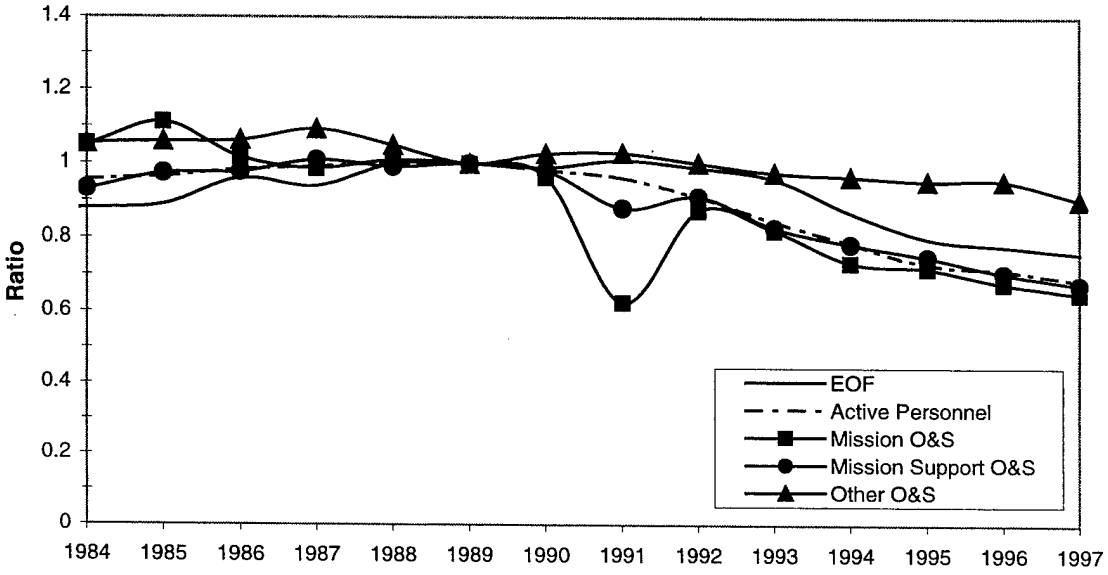

Figure IV-3. Normalized EOF and O&S Spending by Category for the Navy

Table IV-2. Relationship Between Force Size and Mission O&S Spending for the Navy

Explanatory Variable	Coefficients
EOF	1.01
t-value	7.42
Constant	10.19
t-value	409.52
R^2	0.93
Years used	1992–97

By starting our statistical analysis in 1992 we omit the Desert Storm period for which, once again, the contingency adjustment was too large. While a larger sample is desirable, it is important to note that the time from 1992 to 1997 does capture a fall of 22% in mission O&S spending and a fall of 23% in EOF. Thus, this period does include significant reductions in spending and force size.

The fit of the regression as measured by R^2 is quite good, and the coefficient on EOF is highly significant. The results indicate that a 10% reduction in EOF would result in an almost identical 10% reduction in mission O&S spending. Thus, the mission component of O&S funding fell directly in proportion with the reductions in force size. Figure IV-4 shows the actual spending levels against the predictions of the model.

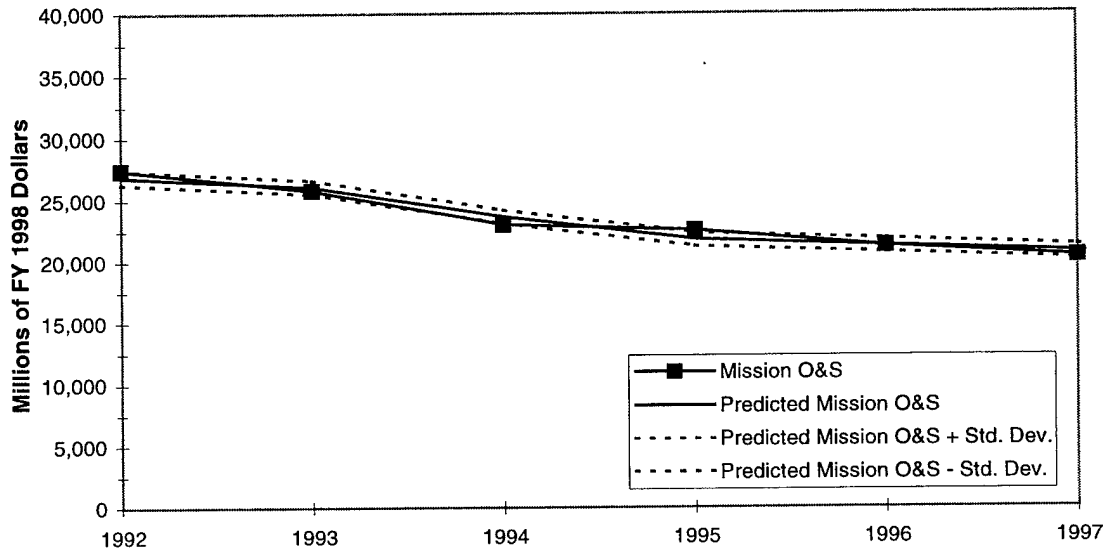

Figure IV-4. Predicted and Actual Mission O&S Spending for the Navy

3. Air Force

Figure IV-5 shows the normalized levels of EOF, mission spending, mission support spending, and other spending for the Air Force for 1982–97. The values have been normalized so that 1989 is equal to one.

Mission O&S and EOF both fell by similar proportions since 1989. This is confirmed in the regression results presented in Table IV-3. The sample covers the years 1984–89 and 1993–97; we dropped 1990–92 again because the contingency correction for Desert Storm was too large. This equation has a very high R^2, and the coefficient on EOF is highly significant. Its value indicates that a 10% reduction in EOF would result in a 10.8% reduction in the required mission O&S spending, pretty much a proportional fall in mission O&S spending. Figure IV-6 shows the actual and predicted values for mission O&S.

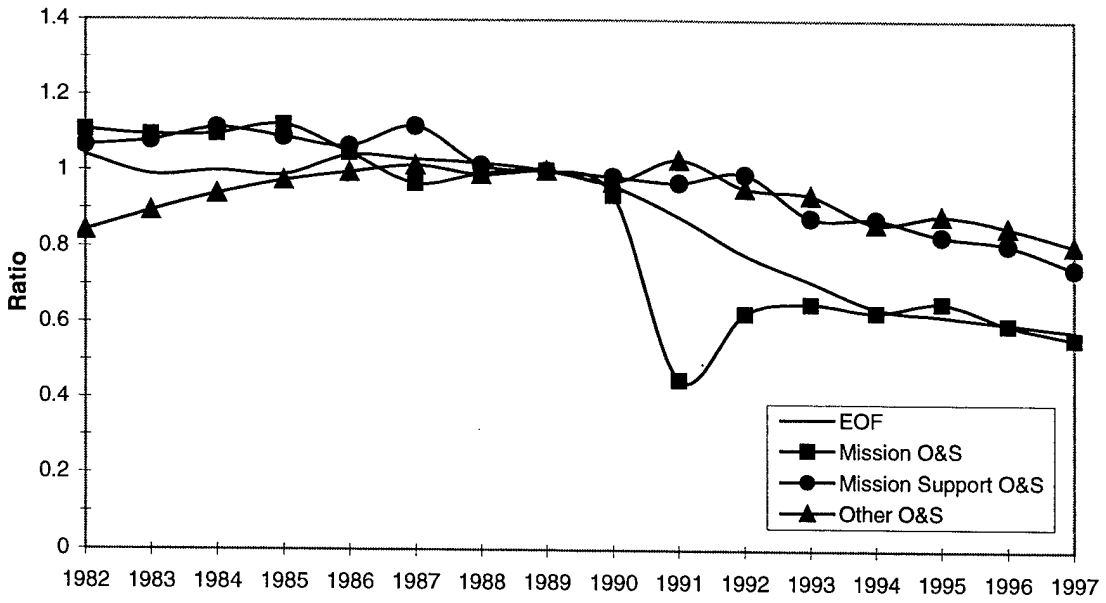

Figure IV-5. Normalized EOF and O&S Spending by Category for the Air Force

Table IV-3. Relationship Between Force Size and Mission O&S Spending for the Air Force

Explanatory Variable	Coefficients
EOF	1.08
t-value	8.98
Constant	10.26
t-value	268.16
R^2	0.96
Years used	1984–89; 1993–97

4. Marine Corps

Figure IV-7 shows the levels of active personnel, mission spending, mission support spending, and other spending for the Marine Corps for 1984–97. All values have been normalized so that 1989 is equal to one. Of all the services, the Marine Corps has experienced the smallest decline in active personnel and mission O&S spending since 1989. Table IV-4 presents the estimated relationship between mission O&S and force size for the Marine Corps.

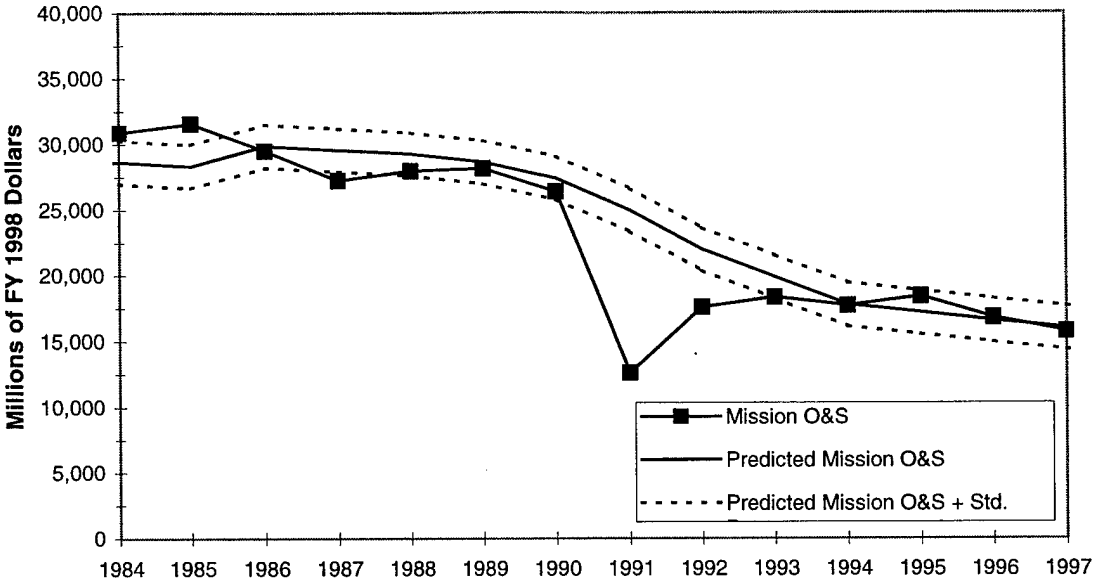

Figure IV-6. Predicted and Actual Mission O&S Spending for the Air Force

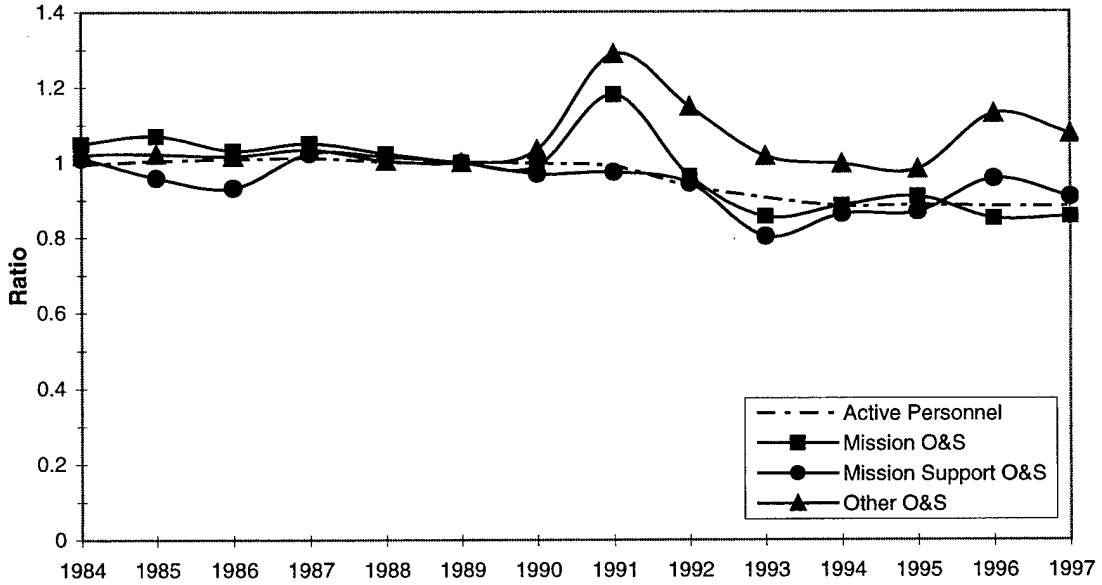

Figure IV-7. Normalized Active Personnel and O&S Spending by Category for the Marine Corps

The years 1990–92 were dropped from the sample because the contingency correction for Desert Storm was not large enough. While this equation has the worst fit of any of the services, it still explains 87% of the variation in mission spending over the period. The coefficient on personnel is very significant, but its value is somewhat high. It indicates that a 10% reduction in personnel would lead to a 14.7% reduction in mission

O&S spending. This indicates that since 1984 the mission component of O&S funding has fallen disproportionately with the reductions in force size. Figure IV-8 shows the predicted and the actual mission O&S funding for the Marine Corps.

Table IV-4. Relationship Between Force Size and Mission O&S Spending for the Marine Corps

Explanatory Variable	Coefficients
Personnel	1.47
t-value	7.78
Constant	-9.14
t-value	-3.98
R^2	0.87
Years used	1984–89; 1993–97

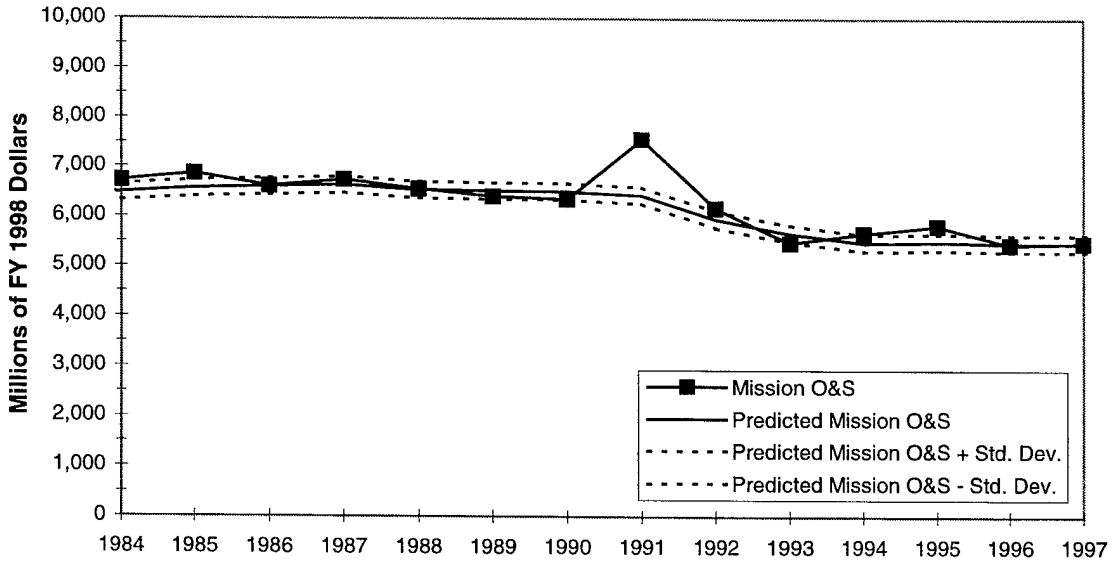

Figure IV-8. Predicted and Actual Mission O&S Spending for the Marine Corps

5. All DoD

Figure IV-9 shows the levels of active personnel, mission spending, mission support spending, and other spending for DoD as a whole. This includes all the Services and the defense agencies. Once again, all values have been normalized so that 1989 is equal to one. Active personnel fell along with mission O&S spending since 1989.

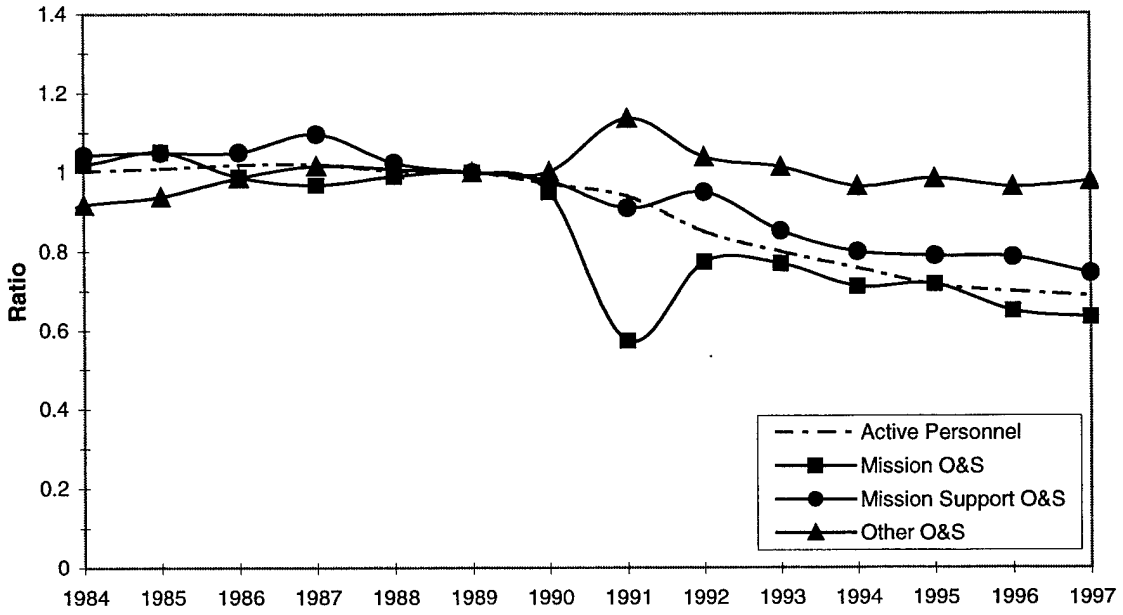

Figure IV-9. Normalized Active Personnel and O&S Spending by Category for all DoD

The estimated relationship between force size and mission O&S spending is presented in Table IV-5. Not surprisingly, we had to drop the years 1990–92 from the sample, again, because the contingency correction for Desert Storm was too large. This equation gives an excellent fit, explaining fully 98% of the variation in mission O&S funding over this period. The coefficient on personnel is highly significant. It indicates that a 10% reduction in personnel would result in an 11.7% reduction in mission O&S spending. Thus, mission O&S funding for all DoD fell roughly in proportion to the reduction in force size.

Table IV-5. Relationship Between Force Size and Mission O&S Spending for All DoD

Explanatory Variable	Coefficients
Personnel	1.17
t-value	19.29
Constant	-5.52
t-value	-6.30
R^2	0.98
Years used	1984–89; 1993–97

Figure IV-10 shows the predicted and actual mission O&S spending for all DoD.

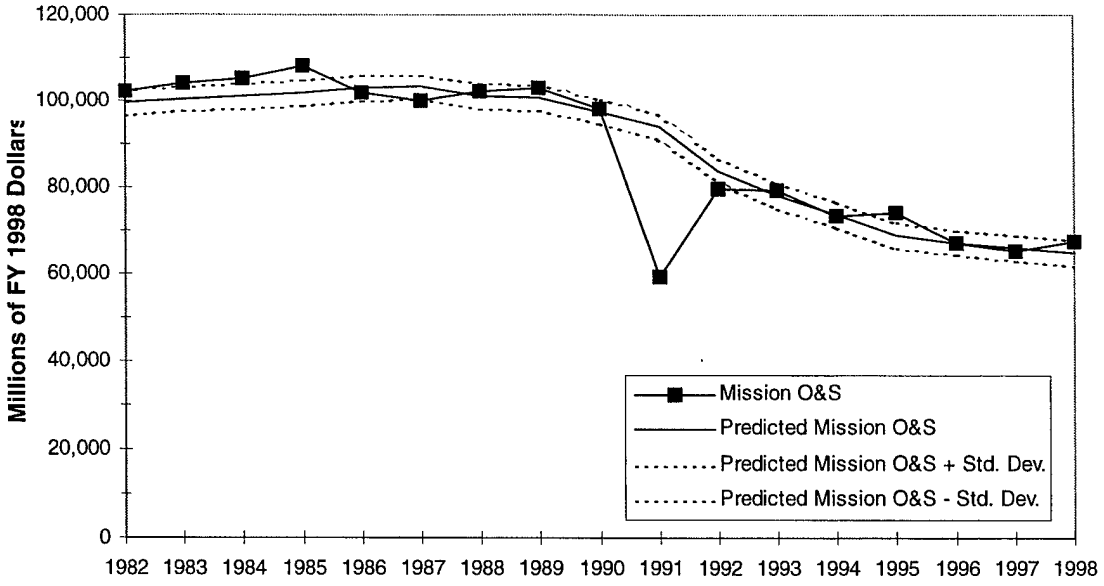

Figure IV-10. Predicted and Actual Mission O&S Spending for All DoD

B. MISSION SUPPORT SPENDING

The mission support and other spending categories can be thought of as providing the funds needed by the infrastructure that supports the readiness-related activity funded by mission spending. Therefore, rather than relating spending in these categories directly to force size, we instead related them to mission spending. That is, we modeled the level of mission support spending as depending on the amount of mission spending it is required to support. Mission support is indirectly related to force size because the amount of mission spending changes with force size.

Figures IV-1, 3, 5, 7, and 9, show that mission support spending fell for all Services and DoD as a whole since 1989, but it did not fall as fast as mission spending. We hypothesize that there is a lag in the response of mission-support funding. That is, while a change in mission spending has some immediate impact on mission support spending, it actually takes several years for the full impact of the change in mission spending to be felt. To capture this behavior, the lagged value of mission support was also included in the regression equation. The final form of the regression used for each service and for DoD as a whole was as follows:

$$\text{mission support}_t = a + b \times \text{mission}_t + c \times \text{mission support}_{t-1}$$

The form is additive. Now a \$1 decrease in mission O&S spending will result in a \$$b$ decrease in mission support spending in that period. However, because of the lagged

variable, even with no further change in mission spending, mission support spending will continue to fall as the infrastructure completes its response to the initial reduction in mission spending. The full impact of a $1 decrease in mission spending is equal to $b/(1 - c)$. This is sometimes called a partial adjustment mechanism. Some of the long-term adjustment, a proportion equal to $1 - c$ of the remaining adjustment, occurs each year.

The results for all four Services and all DoD are presented in Table IV-6. First, notice that the sample size has been expanded to include 1975–89 and 1993–97. This period includes the "hollow years" when readiness was inadequate. However, the model we used specifies that the relationship between mission spending and mission support spending will hold regardless of the adequacy of funding for readiness. That is, the low levels of readiness experienced during the hollow years were due to under-funding of mission O&S. During that time, however, mission support O&S was funded at a level capable of supporting the amount of readiness-related activity permitted by the level of mission O&S spending. This contention is supported by the fact that regressions run on data for 1984–89 and 1993–97 yielded similar coefficients to regressions run on the longer period. However, because of the larger sample size when all years are included, we were able to estimate the coefficients with greater precision. Furthermore, using the larger sample size changed none of the conclusions regarding the adequacy of future funding for mission support. Again, we dropped the Desert Storm years 1990–92 from the sample due to problems with the correction for contingency funding.[1]

The coefficients on mission O&S and lagged mission support O&S are significant in all cases. The coefficient on mission O&S tells us the immediate impact a $1 change in mission spending has on mission support spending. For example, for the Army a $1 reduction in mission spending would lead to a reduction in mission support spending of $0.23 immediately. The long-term impact line shows the effect that a $1 change would have as it worked itself out over the coming years. The long-term impact of that $1 decrease for the Army is $0.43. In each case the long term impact of a $1 change in mission spending is less than $1, ranging from $0.33 to $0.43. Since mission support O&S spending is generally more than half as great as mission O&S spending, this implies

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1 The lagged variables for the 1993 observations reflect 1992, not 1989. The analyses presented in this chapter required lagged data on mission support O&S and other O&S. The contingency funding correction that muddled the mission O&S data had no effect on either readiness or other O&S data. Its impact on mission support O&S data (which we assumed made up 10% of contingency funding) should be relatively minor for 1992.

that mission support O&S is somewhat less than proportionately responsive to changes in mission spending.

Table IV-6. Predicting Mission Support O&S Spending

	Army	Navy	Air Force	USMC	All DoD
Mission O&S	0.23	0.14	0.15	0.18	0.21
t-value	2.09	9.79	4.54	2.23	5.55
Lagged mission support O&S	0.46	0.63	0.60	0.46	0.47
t-value	2.14	10.82	4.78	2.26	4.01
Constant	1,362	78	2,011	460	4,688
t-value	0.51	0.21	1.49	1.31	1.55
R^2	0.89	0.98	0.92	0.74	0.95
Years used	1975–89; 1993–97	1975–89; 1993–97	1975–89; 1993–97	1975–89; 1993–97	1975–89; 1993–97
Long-term impact	0.43	0.38	0.38	0.33	0.40

Note: All the equations were tested for auto-correlation. It was not a problem for the Air Force, Marine Corps or all DoD equations. The Army and Navy equations incorporate an auto-correlation correction procedure.

Figures IV-11 through IV-15 show the actual and fitted values for mission support O&S funding for each Service and all DoD.

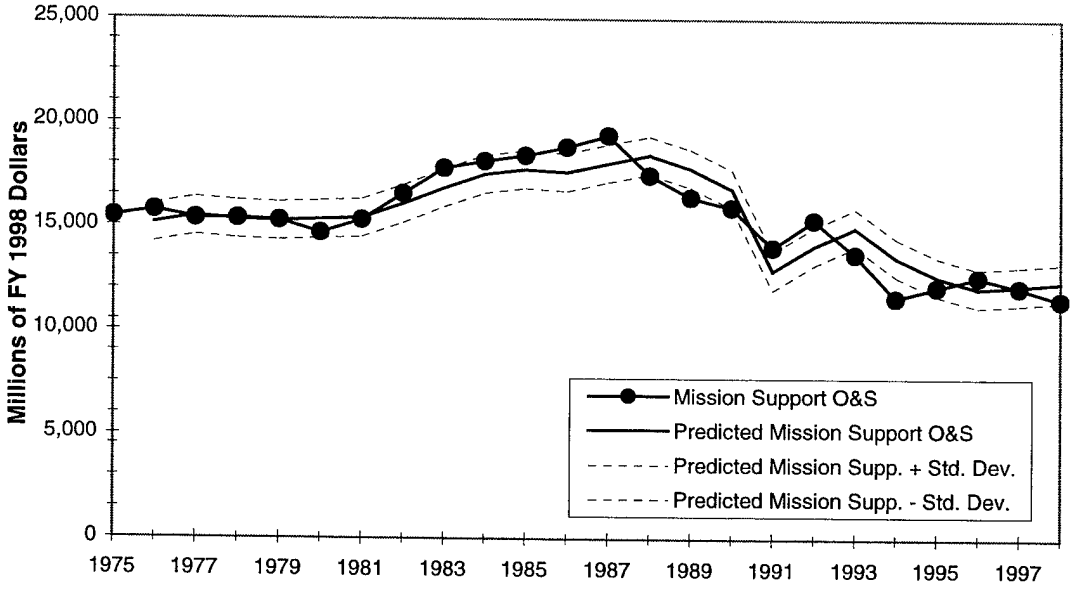

Figure IV-11. Predicted and Actual Mission Support O&S Spending for the Army

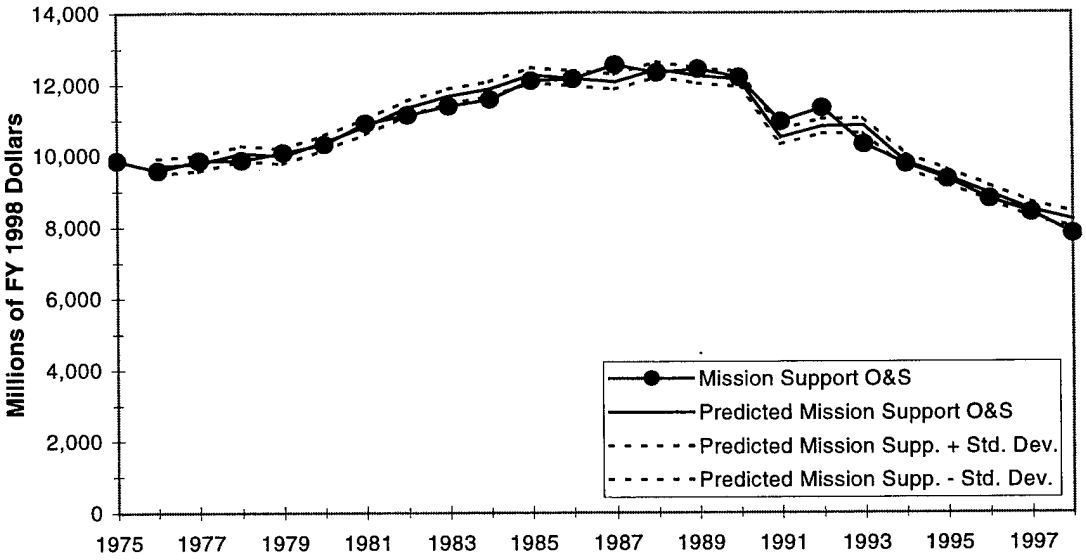

Figure IV-12. Predicted and Actual Mission Support O&S Spending for the Navy

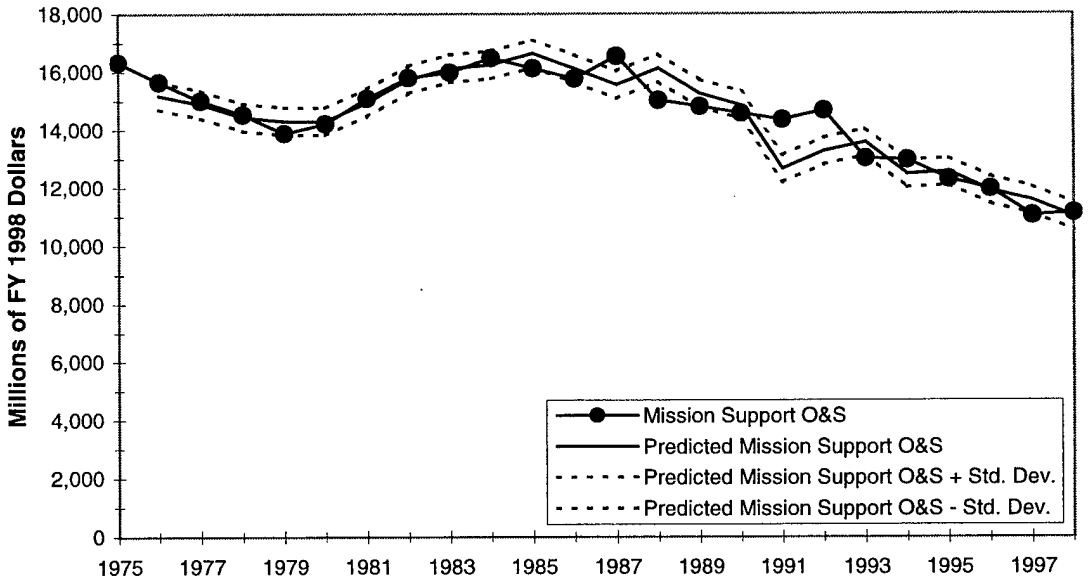

Figure IV-13. Predicted and Actual Mission Support O&S Spending for the Air Force

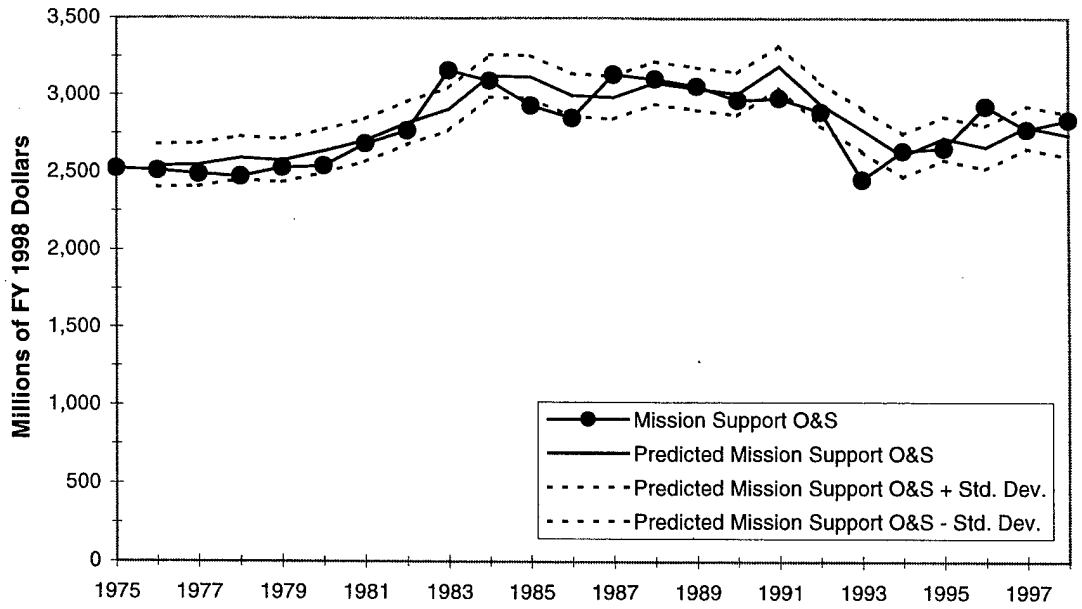

Figure IV-14. Predicted and Actual Mission Support O&S Spending for the Marine Corps

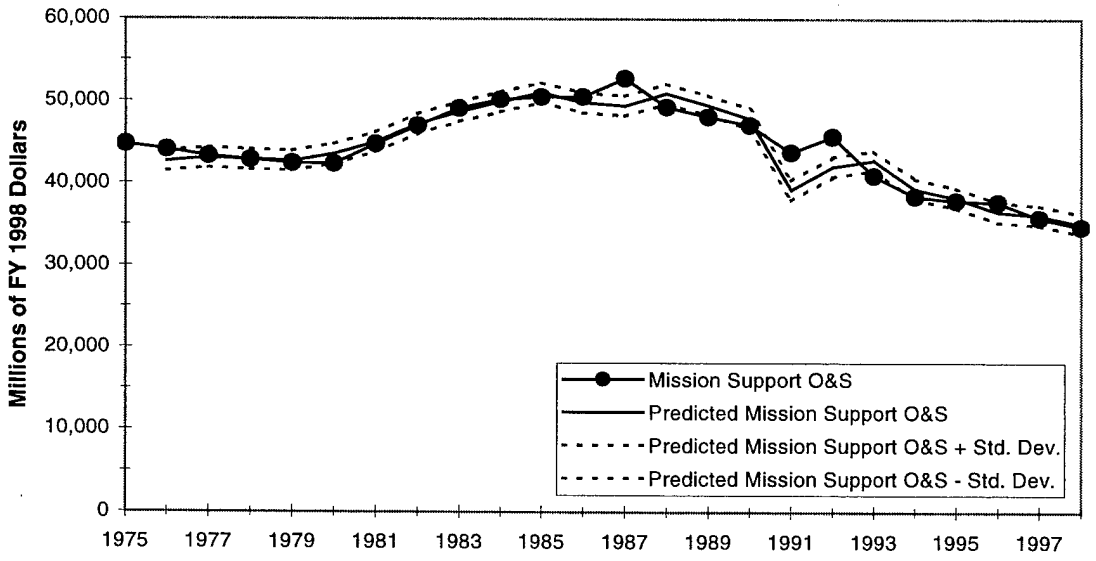

Figure IV-15. Predicted and Actual Mission Support O&S Spending for All DoD

C. OTHER SPENDING

Figures IV-1, -3, -5, -7, and -9 (as well as Figure II-2 in Chapter II) show that other O&S spending did not fall as much since 1989 as did mission and mission support spending. This is particularly true for the Marine Corps (Figure IV-7) and all DoD

(Figure IV-9), where there has been little decrease in O&S spending. This pattern is due to increased spending on such things as environmental cleanup and medical costs.

We followed the same logic in modeling other spending as we did in modeling mission support spending. Thus, we expected that other spending would be linked to mission spending. However, looking at the raw data, it seems that this relationship is less strong than it was for mission support spending. As in the case of mission support O&S, we expected other spending to respond to changes gradually. The regression equation used was as follows:

$$\text{other}_t = a + b \times \text{mission}_t + c \times \text{lagged other}_{t-1}$$

Table IV-7 shows the regression results. Except for the Air Force and all DoD, all the years were used in the sample. The results for the Air Force and all DoD were implausible when all years were used. Therefore, we used only the years 1984–89 and 1993–97, omitting the years around the time of Desert Storm, for the Air Force and all DoD.

Table IV-7. Predicting Other O&S Spending

	Army	Navy	Air Force	USMC	All DoD
Mission O&S	0.14	0.06	0.10	0.02	0.03
t-value	3.67	2.57	6.70	0.78	2.69
Lagged other O&S	0.68	0.71	0.70	0.44	0.56
t-value	6.38	6.38	6.80	2.42	4.24
Constant	561	1,935	2,406	726	24,951
t-value	0.36	1.65	1.61	2.26	2.69
R^2	0.84	0.84	0.94	0.28	0.69
Years used	1975–89; 1993–97	1975–89; 1993–97	1984–89; 1993–97	1975–89; 1993–97	1984–89; 1993–97
Long-term impact	0.44	0.21	0.33	0.04	0.07
Estimation procedure	Ordinary least squares	Ordinary least squares	Auto-correlation correction	Auto-correlation correction	Ordinary least squares

For all the Services and for DoD as a whole, the coefficients on mission spending are all lower than they were for mission support. This makes sense given the expectation of a weaker relationship between mission O&S and other spending. Likewise, except for the Army, the long-term impact of a reduction in mission spending is much less than it was for mission support spending. It is particularly low for the Marine Corps and all DoD. This corresponds with the pattern we saw in the raw data, where other O&S spending fell only very slightly since 1989 for the Marine Corps and DoD as a whole.

It is not surprising given the raw data that we can only explain 28% of the variation in other spending for the Marine Corps. As for mission support spending, a $1 change in mission spending leads to less than a $1 change (and a less than proportionate change) in other spending. This could be partly due to other spending having a larger fixed component than mission spending. It could also be partly due to the fact that some components of other spending, such as intelligence, communications, and environmental cleanup, have been exogenously growing in importance in recent years. Figures IV-16 through IV-20 present the actual and fitted values of other O&S for each Service and for all DoD.

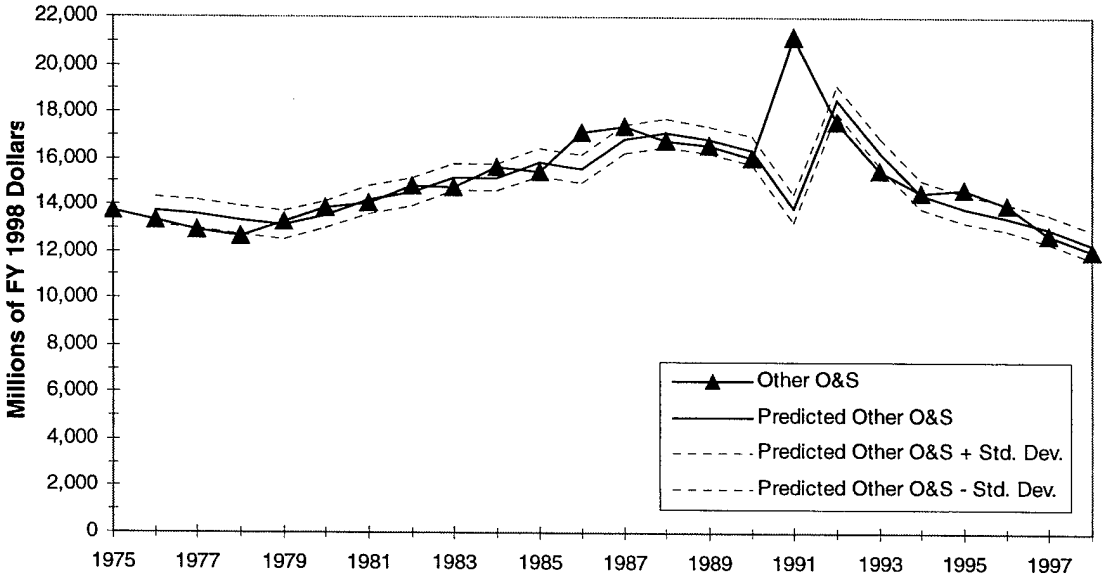

Figure IV-16. Predicted and Actual Other O&S Spending for the Army

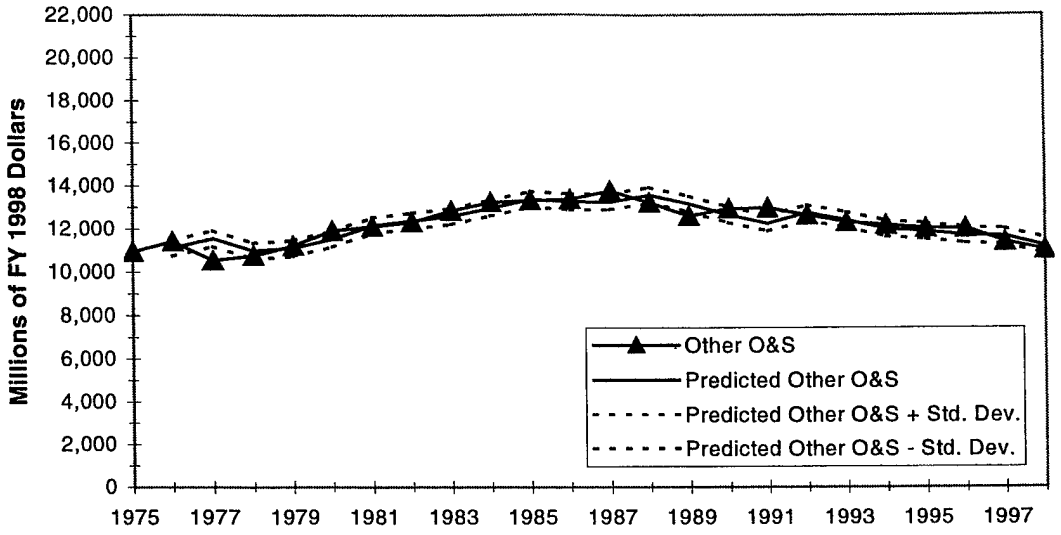

Figure IV-17. Predicted and Actual Other O&S Spending for the Navy

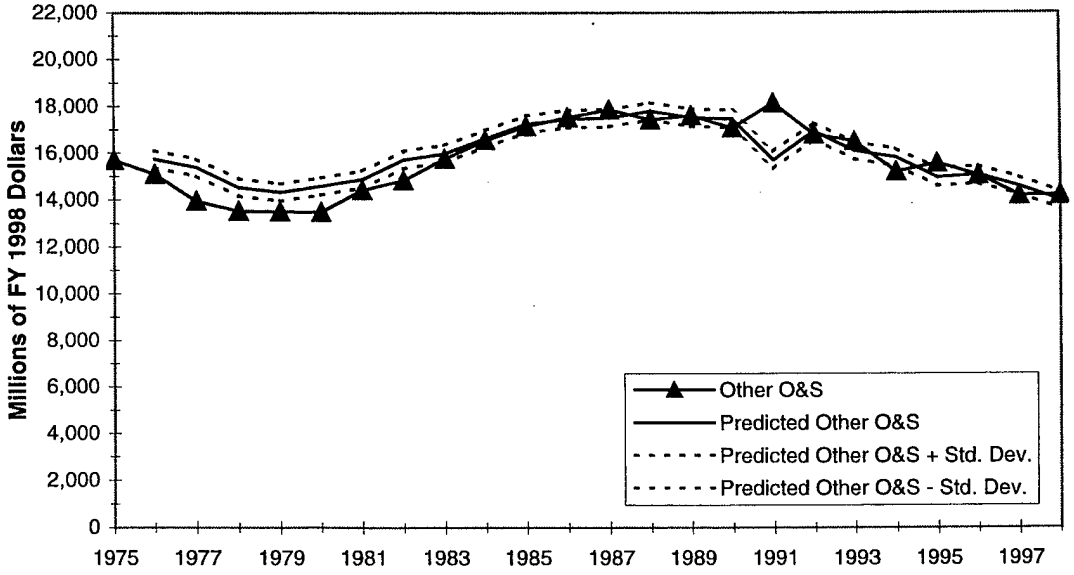

Figure IV-18. Predicted and Actual Other O&S Spending for the Air Force

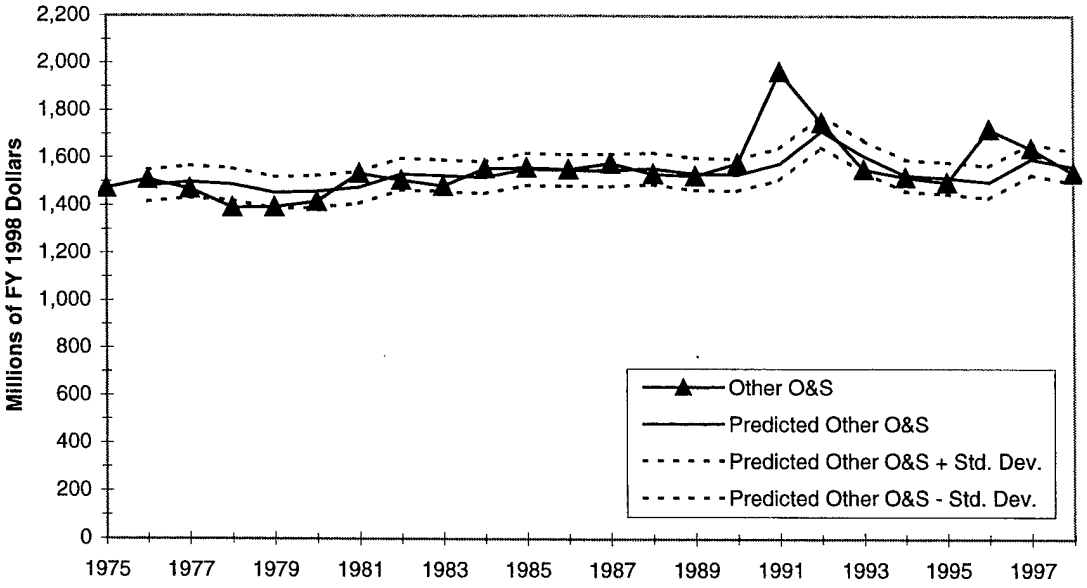

Figure IV-19. Predicted and Actual Other O&S Spending for the Marine Corps

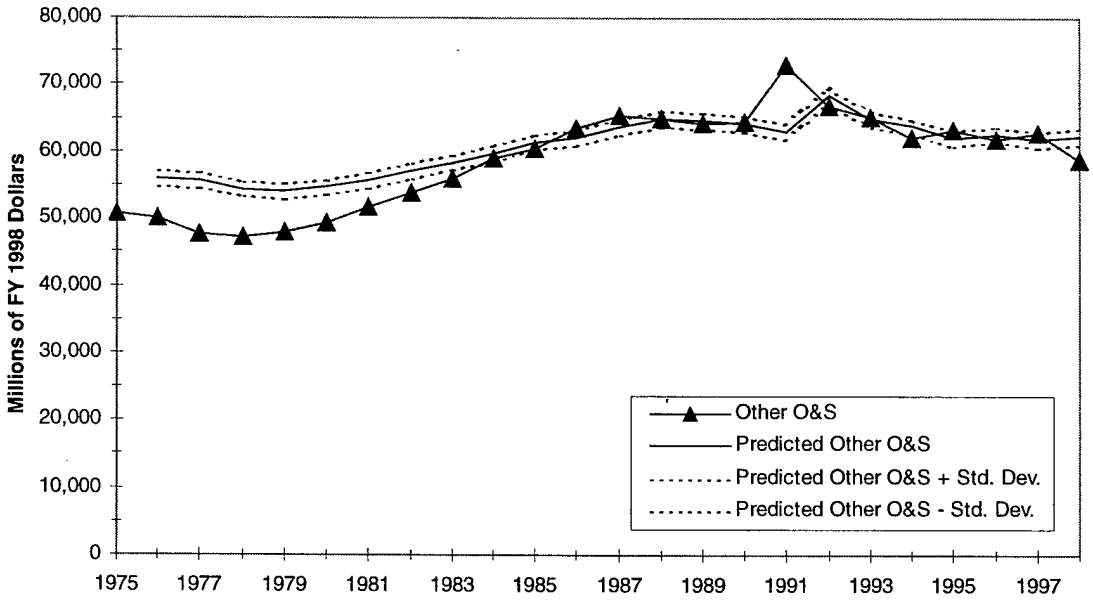

Figure IV-20. Predicted and Actual Other O&S Spending for All DoD

D. DISCRETIONARY MISSION O&M

Operations and support spending includes both military personnel costs and salaries for civilians (the latter as part of the operations and maintenance account). These

salaries must be paid. Therefore, one might consider that, in the short run, the portion of mission O&S that goes to pay personnel is predetermined. If we remove military pay and the civilian pay portion from mission O&S funding, it moves us closer to a measure of the amount of funding available to maintain readiness. We refer to the remaining funding, once military and civilian pay have been removed, as discretionary O&M because how in which these funds are spent is up to the discretion of those in charge.

Unfortunately, we did not have the exact amount of civilian pay for each program element (PE); only the number of civilians paid out of the PE is available. For example, we knew that ten civilians were programmed to be paid out of a particular PE, but we did not know how much they were paid. However, we did know the total amount of civilian pay and the total number of civilians employed by DoD in each year. From this, we calculated the average civilian pay in each year and multiplied it by the number of civilians in that PE to get an estimate of the amount of funding in that PE devoted to civilian pay. We then subtracted this amount from the total amount of O&M funding in that PE to get our estimate of the amount of O&M funding that is discretionary. We followed this procedure for all the PEs in the mission O&M category to get the discretionary mission O&M funding year by year. We estimated discretionary O&M for the Army, Air Force, and Navy.[2]

Given the discretionary O&M data, we examined how the ratio of discretionary mission O&M to total mission O&M has behaved over time. If the ratio fell, it indicates that the share of civilian pay in total mission O&M increased. This implies that civilian pay did not decline in proportion with the decline in total mission O&M funding.

Next, we looked at the relationship between discretionary mission O&M and force size, following the same technique as for mission O&S spending. We developed a statistical relationship between discretionary mission O&M and force size for the years 1984–97, when readiness was felt to be adequate. The reason for performing this analysis was to focus as closely as possible on the impact of changes in force size on that part of the budget that is critical in maintaining readiness and most subject to discretionary control.

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2 We did not pursue Marine Corps or all-DoD analyses of discretionary O&M because the results for the other three Services were not much different from the mission O&S analyses results. In the case of the Marine Corps, few civilians are associated with mission PEs. The all-DoD case amounts to the sum of the Services, since few defense agency PEs are in the mission category.

1. Army

Of the three Services we examined, the Army had the largest share of mission O&M funding devoted to civilian pay. Figure IV-21 shows the trend in discretionary mission O&M funding for the Army. There has been a general downward trend in the ratio of discretionary mission O&M to total mission O&M. This indicates that civilian pay expenditures did not fall proportionately with the decline in total mission O&M. The ratio is currently below levels in the 1970s.

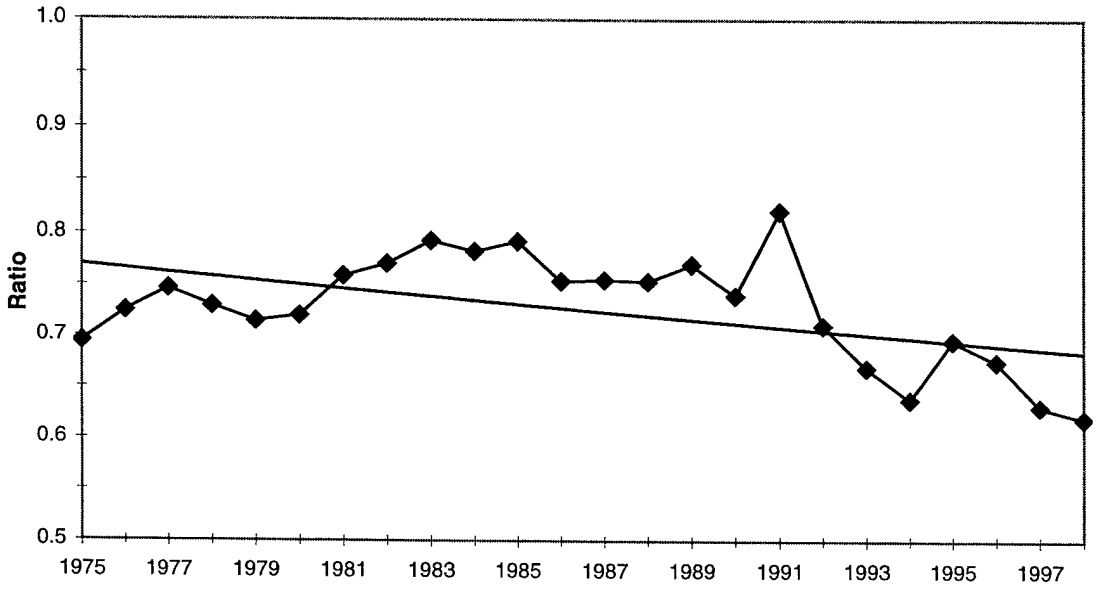

Figure IV-21. Ratio of Discretionary Mission O&M to Total Mission O&M for the Army

We regressed the amount of discretionary mission O&M in every year against the number of active personnel for 1984–97, dropping the Desert Storm years. The results are presented in Table IV-8. The coefficient on active personnel indicates that a 10% reduction in personnel resulted in a 10.6% reduction in discretionary mission O&M, slightly greater than a one-for-one change. This estimated effect is higher than the 9.1% we estimated in the mission O&S analysis.

Figure IV-22 shows the actual and predicted discretionary mission O&M for the Army.

Table IV-8. Predicting Discretionary Mission O&M Spending for the Army

Explanatory Variable	Coefficients
Active Personnel	1.06
t-value	7.59
Constant	-5.35
t-value	-2.86
R^2	0.83
Years used	1984–89; 1993–97

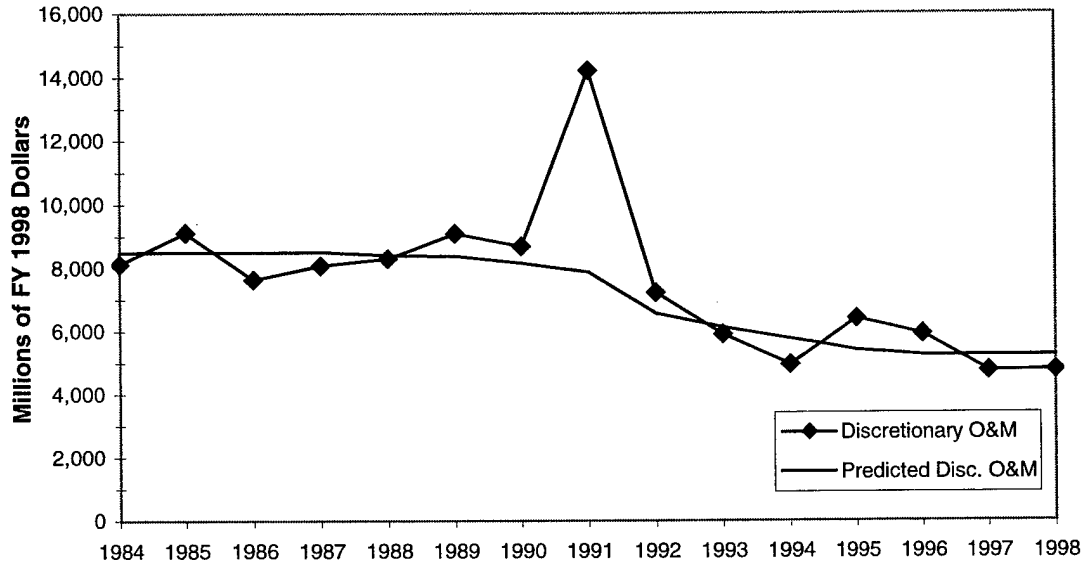

Figure IV-22. Predicted and Actual Discretionary Mission O&M Spending for the Army

2. Navy

Of the three services we examined, the Navy had the smallest share of mission O&M funding devoted to civilian pay. Figure IV-23 shows the trend in discretionary mission O&M funding for the Navy. The ratio of discretionary mission O&M to total mission O&M held steady until 1987 and fell since then. This indicates that civilian pay did not fall proportionately with the decline in total mission O&M since the late 1980s, though it still makes up a small portion of mission O&M.

We regressed the amount of discretionary mission O&M in every year against the EOF for 1992–97, the same period we used in the total mission O&S analysis. The results are presented in Table IV-9. The coefficient on EOF indicates that a 10% reduction in

EOF has resulted in a 12.6% reduction in discretionary mission O&M, more than a one-for-one change. As was the case with the Army, this estimated effect is greater than that obtained in the mission O&S analysis (10.1%).

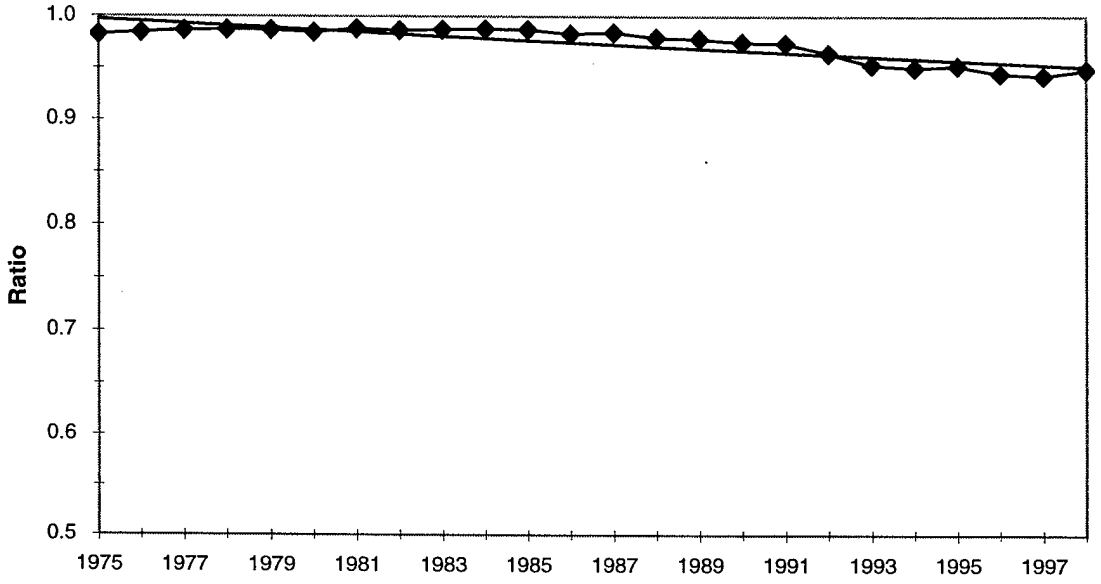

Figure IV-23. Ratio of Discretionary Mission O&M to Total Mission O&M for the Navy

Table IV-9. Predicting Discretionary Mission O&M Spending for the Navy

Explanatory Variable	Coefficients
EOF	1.26
t-value	3.84
Constant	9.60
t-value	170.11
R^2	0.75
Years used	1992–97

Figure IV-24 shows the actual and predicted discretionary mission O&M for the Navy.

3. Air Force

Civilian spending is a smaller share of total mission O&M for the Air Force than it is for the Army, but more than it is for the Navy. Figure IV-25 shows the trend in discretionary mission O&M funding for the Air Force. Once again, there was a general downward trend in the ratio of discretionary mission O&M to total mission O&M. This

indicates that civilian pay did not fall proportionately with the decline in total mission O&M. The ratio is currently below levels in the 1970s.

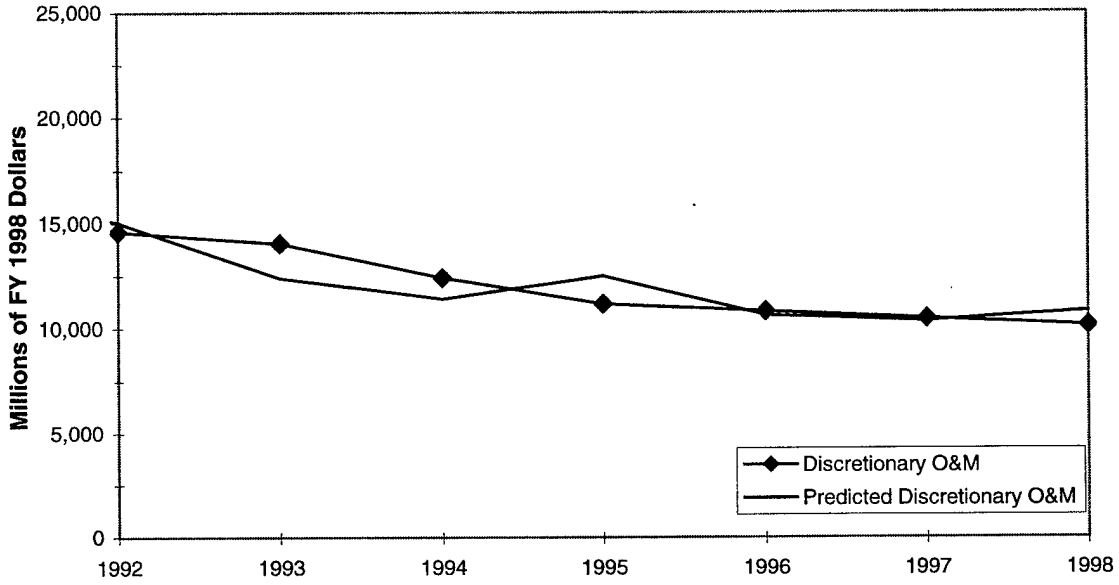

Figure IV-24. Predicted and Actual Discretionary Mission O&M Spending for the Navy

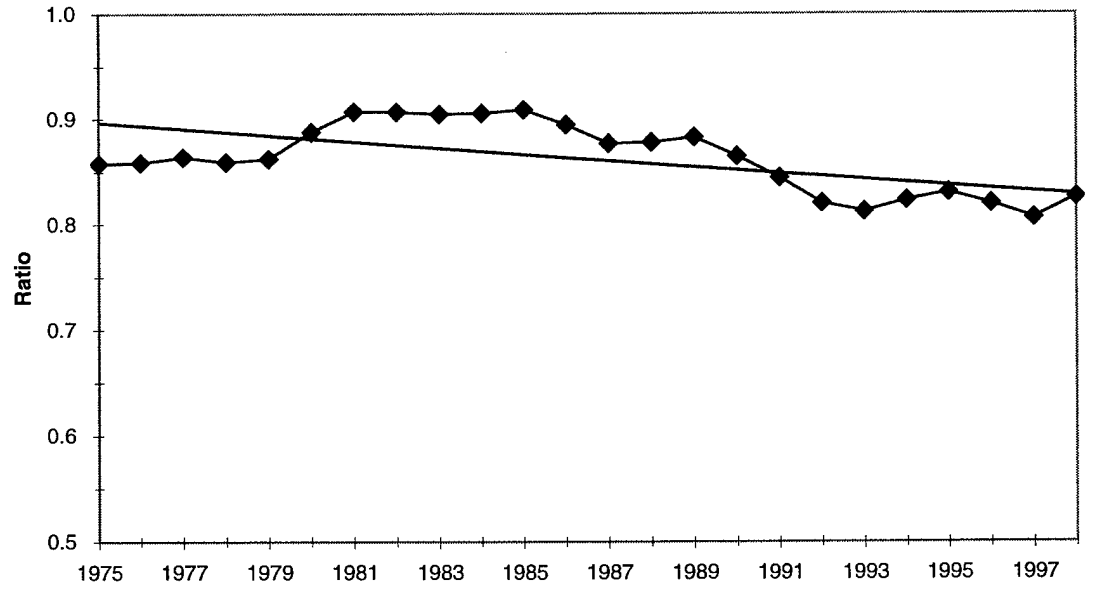

Figure IV-25. Ratio of Discretionary Mission O&M to Total Mission O&M for the Air Force

We regressed the amount of discretionary mission O&M in every year against the EOF for 1984–97, dropping the Desert Storm years. The results are presented in Table IV-10. The coefficient on EOF indicates that a 10% reduction in EOF resulted in a 9.9%

reduction in discretionary O&M, about a one-for-one change. Unlike the Army and Navy, this is below the reduction estimated in the mission O&S analysis (10.8%).

Table IV-10. Predicting Discretionary Mission O&M Spending for the Air Force

Explanatory Variable	Coefficients
EOF	0.99
t-value	6.34
Constant	9.59
t-value	189.10
R^2	0.77
Years used	1984–89; 1993–97

Figure IV-26 shows the actual and predicted discretionary mission O&M for the Air Force.

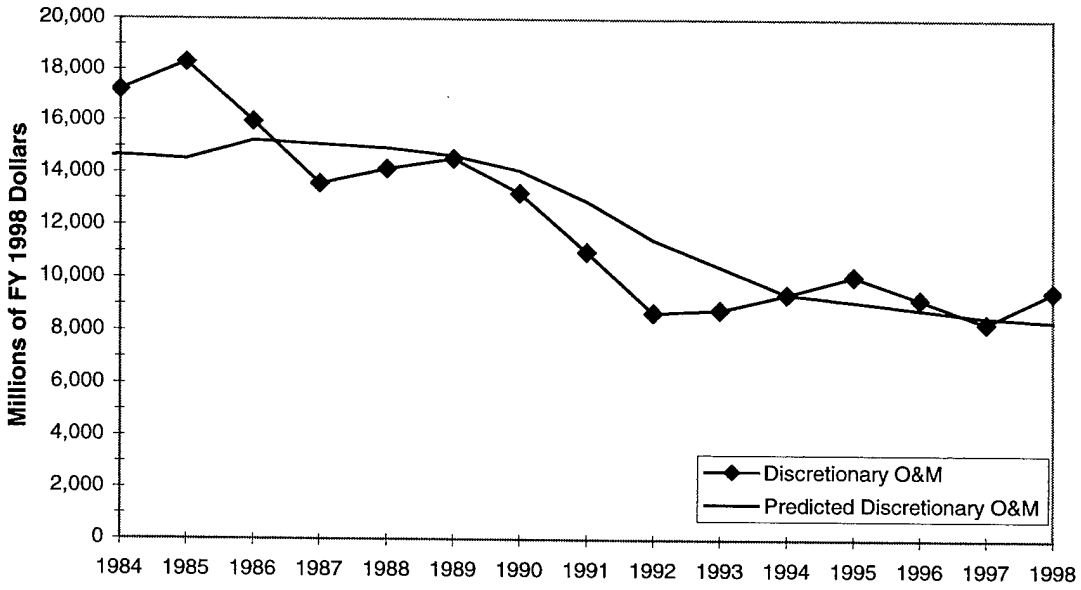

Figure IV-26. Predicted and Actual Discretionary Mission O&M Spending for the Air Force

4. Conclusions

For all three Services we examined, civilian pay accounted for an increasing fraction of mission O&M at least since 1987. We would expect, then, that discretionary mission O&M would be more variable with changes in force size than is mission O&S.

This expectation was fulfilled for the Army and Navy, but not for the Air Force. Of equal interest is the fact that the predictive power of our equations for discretionary mission O&M was not as great as that of the equations for mission O&S (even for the Navy and Air Force, where the independent variable is not related to personnel).

Because the discretionary O&M analyses didn't give appreciably different results and do not provide as much explanatory power, we tend to emphasize the mission O&S analyses in the remainder of this paper.

E. ANALYZING THE ADEQUACY OF PROPOSED FUNDING

Our purpose in performing the statistical analyses was to develop tools to use in analyzing the adequacy of future budgets to maintain readiness. To do such analyses, the planned expenditures must be divided into our three categories—mission, mission support, and other—and examined separately.

For mission spending, it is necessary to have projections of force size, either the number of active personnel or EOF, to carry out the analysis. Then, using the coefficients from our regression, the required level of funding can be calculated for each year. This estimate can then be compared to the actual funding planned. Any differences larger than one standard deviation between the estimated and planned mission O&S spending would indicate potential significant under- or over-funding and should be cause for concern. Also, any prolonged periods where the budgeted mission spending falls above or below the estimates, even by a small amount, would indicate sustained under- or over-funding and should also be cause for concern.

For mission support and other spending, the statistical models can again be used to estimate the level of funding necessary to maintain readiness for a force of the given size. To do this, we need a projection of mission spending in the out-years. Rather than using the planned level of mission spending, we suggest using the estimate of the required mission spending previously calculated. In this way, the estimates of mission support and other spending will be the amounts necessary to support the mission spending required for a force of the size expected in the out-years. Again, large differences between the budgeted amount and the models' predictions and prolonged periods of under- or over-funding should be cause for concern.

F. SUMMARY

Our goal was to develop statistical relationships between force size and funding that could then be used to assess whether or not proposed funding in the out-years is adequate to maintain the readiness of U.S. forces. To do this, we divided spending into three categories: mission spending, mission support spending, and other spending. Mission spending is most closely tied to readiness. We directly related mission spending to one of our measures of force size, either EOF or active-duty personnel, for years when readiness was felt to be adequate. Thus, we assumed that spending in each year approximated the level of funding necessary to maintain readiness for the force size in that year. Our regression results show that mission O&S funding changed about in proportion with force size for the Army, Air Force, Navy, and DoD as a whole. It changed more than proportionately for the Marine Corps.

Because the other two categories of spending (mission support O&S and other O&S) support the level of activity in the infrastructure that is financed by mission spending, we related them to the level of mission spending. Spending in these categories was less variable with force size than was mission spending. Other O&S spending exhibited the least variability with force size.

We also constructed another measure of funding available to support the readiness of forces—discretionary mission O&M. This is mission O&M (mission O&S minus military personnel) funding with an estimate of civilian pay taken out. Analyses of discretionary mission O&M for the Army, Air Force, and Navy indicates that civilian pay did not fall in proportion to reductions in mission O&M funding. However, we found no compelling reason to prefer discretionary O&M to mission O&S as our primary measure of funding most closely linked to readiness.

Finally, we explained how these statistical results could be used to analyze the adequacy of planned budget expenditures to maintain the readiness of the forces. The next chapter examines whether this methodology could have identified the hollow years in the late 1970s and early 1980s when readiness was under-funded.

V. ANALYZING READINESS SPENDING IN THE HOLLOW YEARS

The models developed in the previous chapter were based on the assumption that we could predict the funding necessary to maintain readiness if we knew how much was spent on a given force size during a period of adequate readiness. One test of this assumption would be to go back to a period when readiness was *inadequate* and use our model to predict what spending should have been during that time to raise readiness to desired levels.

We used the period from 1975 to around 1980, the so-called hollow years, when readiness was considered both under-funded and inadequate. Based on force size measures in those years, we used our models to calculate what funding would have been necessary. Our models would be validated if they predicted higher funding in those years than actually occurred. We had funding and force size measures back to 1975 (1976 for the Navy). Using our estimated relationships for mission O&S from the previous chapter, we predicted necessary funding back to 1975 and compared this to the actual funding data we had. Table V-1 repeats the regression results from Chapter IV for mission O&S funding requirements.

Table V-1. Regression Results Relating Force Size to Mission O&S Funding

Explanatory Variable	Army	Navy	Air Force	USMC	All DoD
Personnel	0.91	—	—	1.47	1.17
t-value	9.81	—	—	7.78	19.29
EOF	—	1.01	1.08	—	—
t-value	—	7.42	8.98	—	—
Constant	-1.92	10.19	10.26	-9.14	-5.52
t-value	-1.54	409.52	268.16	-3.98	-6.30
R^2	0.94	0.93	0.96	0.87	0.98
Years used	1984–89; 1993–97	1992–97	1984–89; 1993–97	1984–89; 1993–97	1984–89; 1993–97

A. ALL DoD

Figure V-1 shows the results for all DoD when required mission O&S spending is estimated back to 1975 using the relationship between mission O&S and active-duty personnel derived in the previous chapter. It shows a considerable shortfall in funding through 1981. In 1975, the gap between the required and actual funding (measured in 1997 dollars) was $21.4 billion, or close to 22% of our estimate of the required funding.

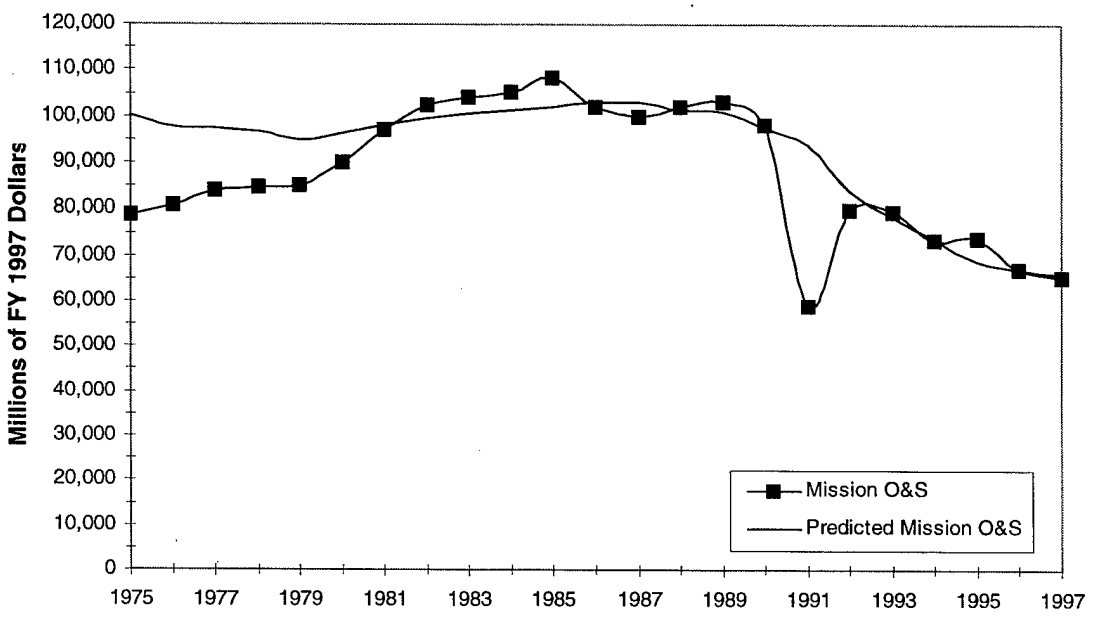

Figure V-1. Predicted and Actual Mission O&S Spending for All DoD, 1975–97

B. ARMY

Figure V-2 presents the results of estimating the required funding for the Army back to the hollow years based on the number of active-duty personnel. Again, there is a dramatic shortfall in funding during the mid-1970s to early 1980s. The shortfall in 1975, as measured in 1997 dollars, is over $8 billion. This amounts to more than 22.7% of our estimate of required funding.

C. NAVY

The Navy is the one case where our model is not validated. We only have EOF data back to 1976. Figure V-3 shows that our model would say that the Navy mission O&S was over-funded throughout the hollow years. In 1976, this over-funding (as

measured in 1997 dollars) amounted to $6.5 billion, or 36.5 % of our estimate of required funding.

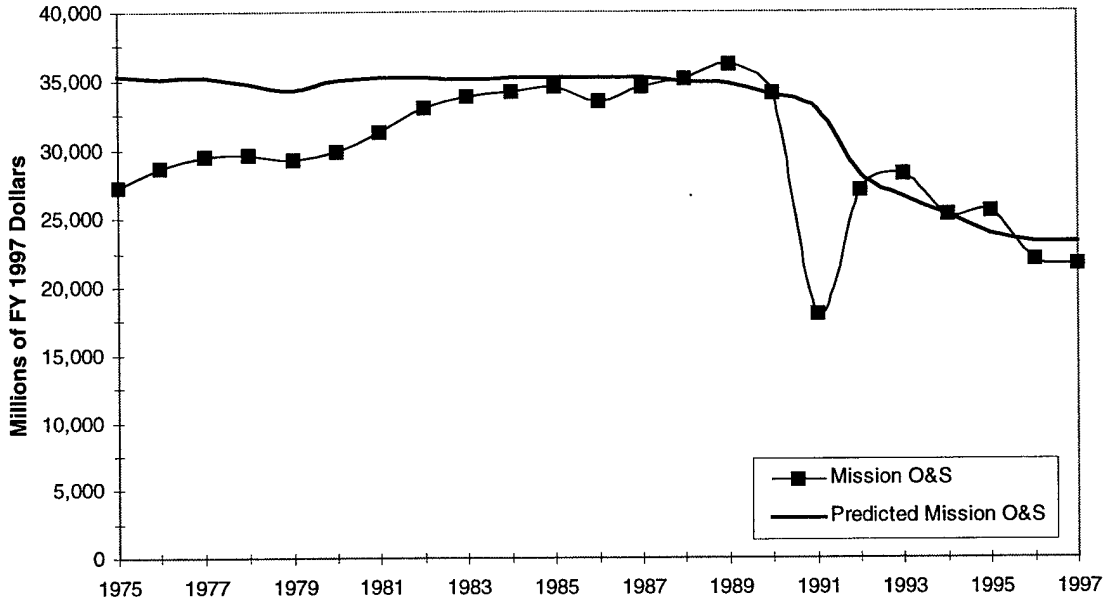

Figure V-2. Predicted and Actual Mission O&S Spending for the Army, 1975–97

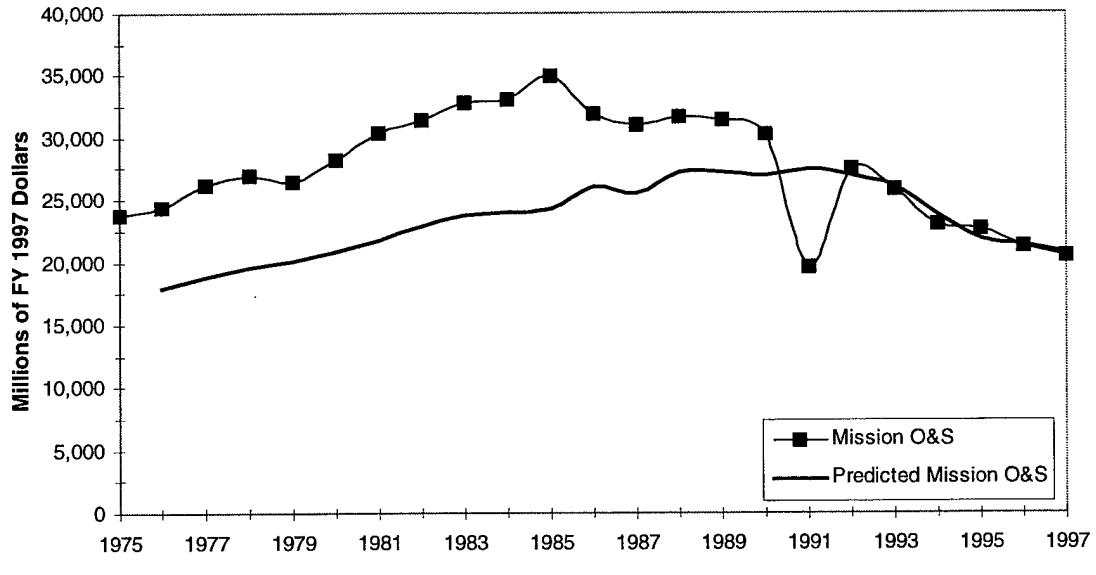

Figure V-3. Predicted and Actual Mission O&S Spending for the Navy, 1976–97

It is important to note that our regression was based on a sample of only the years 1992-97. We mentioned earlier that prior to 1990 Navy mission O&S funding was markedly higher for a given force size than it was after 1991. Figure V-3 certainly confirms this observation. It may be that changes in the frequency with which the Navy overhauls ships contributed to this difference. Another possible explanation involves the greater frequency of expensive service life extensions on aircraft carriers during the 80s.

While our estimated relationship does not do well confirming that the Navy did not adequately fund readiness in the late 70s, it may be a useful tool for assessing future planned readiness spending, as long as the required funding relationship has not changed again.

D. AIR FORCE

For the Air Force Figure, V-4 shows under-funding of mission O&S through 1980, based on our measure of EOF. There was a gap in 1975 of $3.9 billion (as measured in 1997 dollars). This amounted to 14.8% of our estimate of required funding for a force of that size.

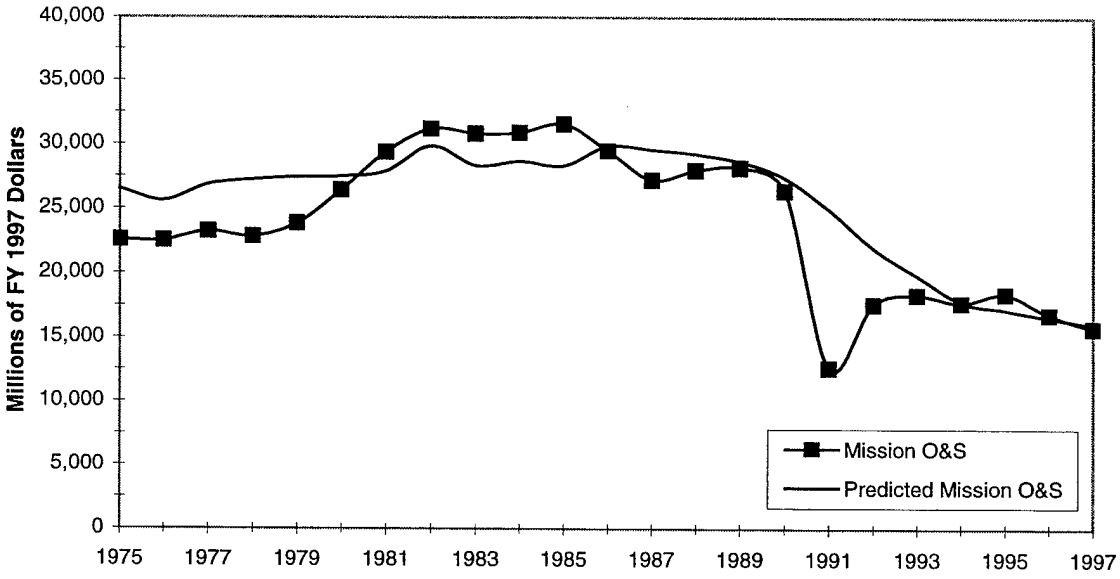

Figure V-4. Predicted and Actual Mission O&S Spending for the Air Force, 1975–97

E. MARINE CORPS

Figure V-5 shows considerable under-funding for the Marine Corps during the late 1970s, based on the number of active duty personnel. There is a gap between our estimate of the funding required and the actual funding of $1.3 billion (as measured in 1997 dollars) or 21% of the required amount.

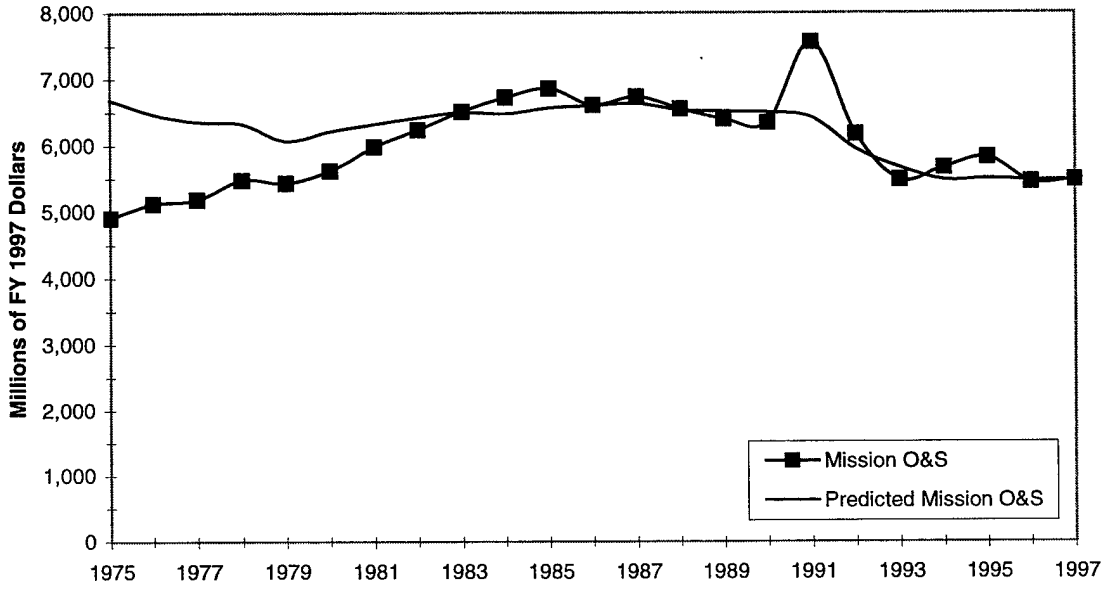

Figure V-5. Predicted and Actual Mission O&S Spending for the Marine Corps, 1975–97

F. SIMPLE RATIO ANALYSIS

Since required spending appears to be roughly proportional to force size, we should be able to track the adequacy of mission O&S spending by looking at the ratio of mission O&S to force size. O&S costs consist of two separate parts: military pay and O&M funding. Did the gap in funding close because of an increase in military pay per person or because of an increase in mission O&M per person? To answer this, the ratios of military pay per person at the all DoD level and mission O&M per person were calculated. Figure V-6 shows these ratios.

It is clear that the gap closed due to an increase in mission O&M per person and not because of an increase in military pay. Military pay per person remained close to its average value of $47,500 (constant 1997 dollars) over the entire time period from 1975 to 1998. However, mission O&M per person rose from $14,800 (constant 1997 dollars) in

1975 to $23,400 in 1982. Since then, it has remained close to its average of $22,500 per person. It appears that mission O&M of this level is adequate to maintain readiness.

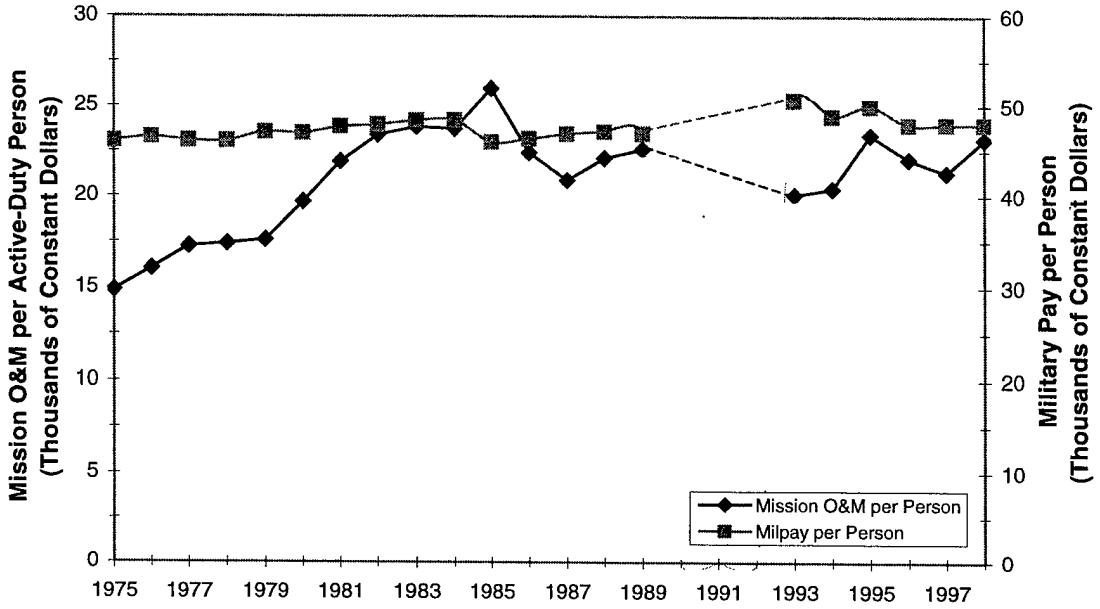

Figure V-6. Military Pay and Mission O&M per Active-Duty Person

G. SUMMARY

We sought to validate our models for each Service and all DoD by comparing the amount of funding our models would predict as the amount required to adequately support the readiness of the troops to what funding actually was during a period when readiness was felt to be inadequate. If our model shows that actual funding was below what was predicted, then this helps validate the empirical relationships we derived.

Therefore, for each of the Services and for all DoD we compared the models' predictions against actual funding during the late 1970s and early 1980s. We found large shortfalls in actual funding compared to the predictions in all cases except for the Navy. The Navy equation likely did not work because the regression is based on only the years 1992–97 precisely because the Navy's required funding relationship seems to have changed between the 1980s and the 1990s.

In general, the methodology for assessing the adequacy of readiness funding appears to be valid. However, care must be taken to be aware of changes in maintenance and support philosophies that can change funding requirements.

VI. RELATING SPENDING TO READINESS

A. BACKGROUND

In previous chapters, we developed relationships between spending and force size over a period of time when readiness was generally believed to be adequate. These relationships gave us a tool to predict the level of funding necessary to maintain a force of a given size at an adequate level of readiness. In this chapter, we describe our attempt to directly relate spending to some measures of the readiness of forces. Our goal was to relate variations in readiness to variations in spending. First, the measures of readiness and force size in the analysis are discussed. Then the two methodologies used are presented. The first method builds on the work in Chapter IV that related spending to force size. The second method relates readiness directly to spending and force size. In the last section, we present the conclusions drawn from the analysis.

B. METHODOLOGY

1. Source of Readiness Information

In order to relate spending to readiness, we needed a measure of force readiness. We used data from the Status of Readiness and Training System (SORTS). Under SORTS, each unit is put into one of five categories:

- C1—a fully ready unit.
- C2—a unit with minor mission degradations.
- C3—a unit with serious degradation to at least one mission.
- C4—a unit that is not mission ready.
- C5—a unit undergoing structural change such as getting new equipment or undergoing overhaul. (We omitted C5 units from the analysis.)

The overall rating given for a unit is the lowest rating it received in the four resource categories of personnel, supply, equipment, and training. Because SORTS ratings are the subjective opinions of unit commanders, one cannot be confident of their consistency. Nonetheless, SORTS remains the most widely used source of information on the readiness of individual units. We looked only at SORTS ratings for combat units. Our

annual observations were based on an average of 1,440 reporting units: 570 from the Army, 668 from the Navy, 116 from the Air Force, and 86 from the Marine Corps.

2. Measure of Spending

Because we are looking at the readiness of combat units, we focused on spending that is most directly related to them: mission spending. Mission spending is spending on combat units, deploying support, and depot maintenance. This is the spending that should be the most closely related to readiness. We look at both mission O&S spending and mission O&M spending. Mission O&S spending includes spending on military personnel, an important component of readiness ratings. However, we found that in one case, mission O&M spending provided a better fit to the data.

3. Method 1—Normalized Mission O&S and O&M

Our goal was to statistically relate variations in readiness to variations in spending. Our first approach used readiness spending normalized for force size. We used the residuals from our relationship between force size and spending shown in Chapter IV. The residual is the amount by which actual mission spending differed from the level of spending predicted by the model. The model prediction is what would have been necessary for a given force size, so it was normalized for force size. Therefore, we refer to the residual as normalized mission spending. If the residual is positive, it indicates that funding in that year exceeded the benchmark level that was sufficient to maintain adequate readiness for a force of that size. Likewise, if the residual is negative, it indicates under-funding relative to the benchmark level for a force of that size in that year.

We expect that this over-funding (under-funding) would have a positive (negative) impact on readiness. Thus, in years when our mission spending equation had a positive residual, we expect the percentage of units reporting C1 to increase. In addition, it is possible that the effect would be delayed. That is, the excess funding may take a while to have an impact on readiness. It may take 1 or even 2 years for the full impact to be felt.

The final form of the equation we fit was

$$\ln\left(\frac{p_t}{1-p_t}\right)=\alpha_0+\alpha_1 * \ln\left(NORMOS_{t,t-1,t-2}\right),$$

where

p_t = the proportion of units reporting C1 in period t and

$NORMOS_{t,t-1,t-2}$ = the value of normalized O&S in either period t, $t-1$, or $t-2$.

The regression analysis was also performed using normalized mission O&M spending. We used the following form of the dependent variable, called the logit regression, to ensure that predictions will lie between 0% and 100%:

$$\ln\left(\frac{p_t}{1-p_t}\right).$$

With this formulation, the model will never predict less than 0% or more than 100% of units reporting C1.

It is interesting to note how the percentage of units reporting C1 changes as the level of funding changes. Figure VI-1 illustrates how the percentage of units reporting C1 rises consistently as the level of normalized mission O&M spending rises. At first, the percentage rises slowly (presumably because most units aren't anywhere near being able to get to C1), then reaches a point at which small increases in spending would result in large increases in the percentage of units reporting C1. At some point, however, diminishing returns set in. Then it takes large increases in the level of funding to produce even small increases in the percentage of units reporting C1.

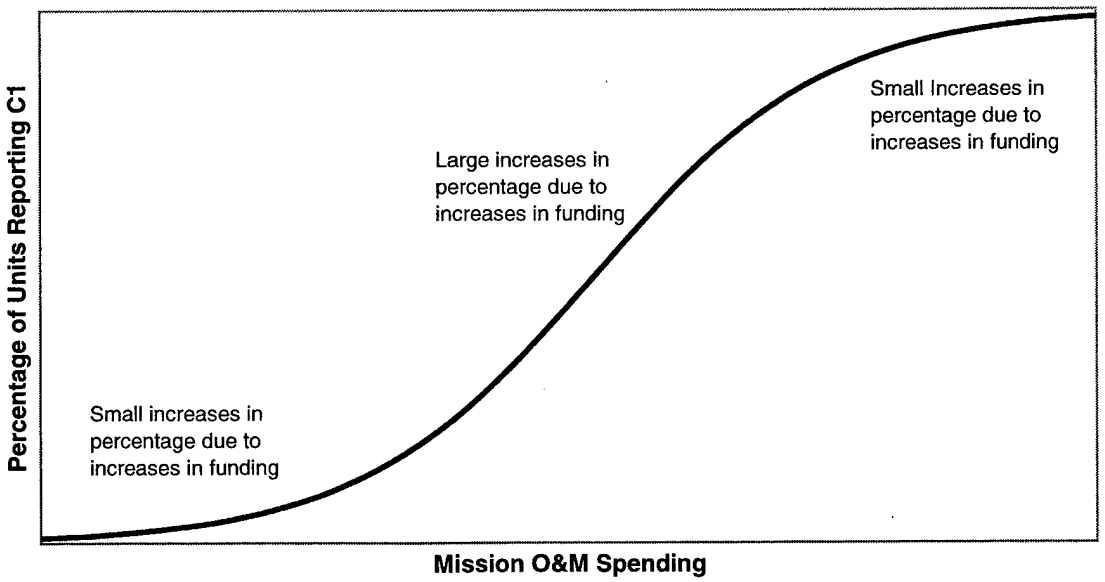

Figure VI-1. Change in the Percentage of Units Reporting C1 due to a Change in Normalized Mission O&M Spending

The same analysis was also done for the percentage of units reporting C1 or C2. We did the analysis at the all-DoD level, combining data on readiness and spending for all the Services. The observations are annual. We had to use annual readiness ratings because the spending data are only available on an annual basis. The percentages reflect the number of unit-months in a readiness category for a fiscal year. The data cover the years from 1985 to 1996. The year 1991 had to be dropped because of the spike in funding caused by Desert Storm.[1] Table VI-1 presents the results for the percentage of units reporting C1 using normalized mission O&S, and Table VI-2 presents the results for the percentage of units reporting C1 using normalized mission O&M as the explanatory variable. Table IV-3 presents the results for units reporting C1 or C2 using normalized mission O&S, and Table IV-4 presents the results for units reporting C1 or C2 using normalized mission O&M. Since there is no standard measure of fit for logit regressions, the R^2 values presented in this chapter were calculated in the following way:

$$R^2 = 1 - \frac{\sum(\text{predicted} - \text{actual})^2}{\sum(\text{actual} - \text{mean})^2}.$$

The values are the percentages predicted by the model, the actual percentages in the data, and the mean value of the percentages in the data. The resulting measure of R^2 has the conventional interpretation of being the percentage reduction in variance gained by using the predictive relationship instead of using the mean of the data to estimate individual observations.

Table VI-1. Regression Results for the Percentage of Units Reporting C1 (O&S)

	Coefficient	*t*-value	Change in Readiness per $1 Billion Change in Mission O&M	R^2
Constant	-0.71	—	—	0.60
Normalized Mission O&S	0.03	15.28	0.6%	—
Constant	-0.71	—	—	0.65
Normalized Mission O&S (lagged 1 Year)	0.04	22.16	0.8%	—
Constant	-0.64	—	—	0.76
Normalized Mission O&S (lagged 2 Years)	0.04	27.25	1.0%	—

[1] Because the second regression in the table included the lagged value of spending, it was actually 1992 that was dropped since the explanatory variable in this case would be the 1991 value of spending. Likewise, for the last regression, which had spending lagged 2 years as its explanatory variable, year 1993 had to be dropped.

Table VI-2. Regression Results for the Percentage of Units Reporting C1 (O&M)

	Coefficient	*t*-value	Change in Readiness per Billion $ Change in Mission O&M	R^2
Constant	-0.74	—	—	0.64
Normalized mission O&M	0.04	20.66	0.9%	—
Constant	-0.77	—	—	0.70
Normalized mission O&M (lagged 1 year)	0.06	30.67	1.4%	—
Constant	-0.70	—	—	0.82
Normalized mission O&M (lagged 2 years)	0.07	26.32	1.5%	—

Table VI- 3. Regression Results for the Percentage of Units Reporting C1 or C2 (O&S)

	Coefficient	*t*-value	Change in Readiness per $1 Billion Change in Mission O&M	R^2
Constant	1.01	—	—	0.58
Normalized mission O&M	0.03	15.68	0.6%	—
Constant	1.00	—	—	0.52
Normalized mission O&M (lagged 1 year)	0.02	9.35	0.3%	—
Constant	1.04	—	—	0.35
Normalized mission O&M (lagged 2 years)	0.001	0.25	0.01%	—

Table VI-4. Regression Results for the Percentage of Units Reporting C1 or C2 (O&M)

	Coefficient	*t*-value	Change in Readiness per $1 Billion Change in Mission O&M	R^2
Constant	0.99	—	—	0.51
Normalized Mission O&M	0.03	12.61	0.5%	—
Constant	0.98	—	—	0.42
Normalized Mission O&M (lagged 1 Year)	0.02	10.61	0.4%	—
Constant	1.04	—	—	0.30
Normalized Mission O&M (lagged 2 Years)	-0.01	-3.34	-0.1%	—

Because of the functional form used, the coefficients for the explanatory variables do not translate directly into the marginal effects. Rather, the marginal effect on readiness of a change in spending needs to be calculated.[2] The fourth column in the tables shows

2 For details, see William H. Greene, *Econometric Analysis*, Third Edition, Prentice Hall: New Jersey, 1997, p. 876.

the increase in the percentage of units reporting C1 (or C1 or C2) from a $1 billion increase (in FY 1998 dollars) in mission O&S spending. This increase yields an increase of 0.6% to 1.0% in the percentage reporting C1, but only a 0.3% to 0.6% increase in the percentage reporting C1 or C2. For normalized mission O&M, the same increase yields an increase of 0.9% to 1.5% in the percentage reporting C1, but only a 0.4% to 0.5% increase in the percentage reporting C1 or C2.

The larger percentage increase in C1 indicates that more of the extra spending goes to lifting units to C1 status from C2 than to lifting units from C3 or C4 into the C1 or C2 categories. The percentage reporting C1 regression indicates that the effect of an increase in spending is still strong after 2 years. However, the percentage reporting C1 or C2 regression shows an effect only lasting 1 year. Both of the regressions indicate only a small or even slightly negative effect 2 years later. The percentage of fully ready units seems particularly sensitive to variations in funding. Neither normalized mission O&S or O&M was as good at predicting the percentage reporting C1 or C2 as it was at predicting the percentage reporting C1.

The relative percentage increases that we estimate are probably due to the high levels of readiness during the observation period. When a large majority of units are already at least C2 an increase in funding must be seen mostly at the top end.

4. Method 2—Mission O&S and Force Size

With this method we attempted to relate readiness directly to force size and spending. We hypothesized that higher mission O&S, holding force size constant, would lead to higher readiness. Likewise, larger force size, holding mission O&S constant, would lead to lower readiness. From our previous analysis, we learned that spending had a lagged effect on readiness. Because it might take a while for changes in funding to translate into changes in readiness, we included a lag term. This lag involves the previous year's percentage of units reporting C1 (or C1 or C2). The inclusion of this term allows readiness to change gradually over time in response to changes in the explanatory variables, mission O&S and force size. The regression we ran was:

$$\ln\left(\frac{p_t}{1-p_t}\right)=\alpha_0+\alpha_1*\ln(p_{t-1})+\alpha_2*\ln(OS_t)+\alpha_3*\ln(ActPers_t),$$

where

p_t = the percentage of units reporting C1 in period t,

p_{t-1} = the percentage of units reporting C1 in period $t-1$,

α_1 = the fraction of the long-term change in readiness achieved in one period,

OS_t = the amount of mission O&S funding in period t, and

$ActPers_t$ = the number of active-duty personnel in period t, our measure of force size.

Once again, we used this functional form to keep predictions between 0% and 100%. We analyzed the percentage of units reporting C1 and the percentage reporting C1 or C2 for DoD as a whole. The measure of force size was the total number of active-duty personnel. The data included years 1986 to 1996. The observation for 1985 had to be dropped because of the lag term on the percentages. Also, 1991 had to be dropped because of the spike in funding due to Desert Storm. The analysis was also performed using mission O&M spending

Table VI-5 presents the results for both the percentage reporting C1 and the percentage reporting C1 or C2 using mission O&S, active personnel, and the lag as explanatory variables. Table IV-6 presents the results when using mission O&M instead of mission O&S spending.

Table VI-5. Regression Results for Spending and Force Size (O&S)

	Coefficient	*t*-value	Carry-over from Last Year	Change in Readiness per $1 Billion Change in Mission O&M	Long-term impact of $1 Billion Change
Percentage reporting C1					
Last year (%)	3.28	20.56	73%	—	—
Mission O&S (FY98 $M)	0.02	5.54	—	0.41%	1.54%
Active personnel (thousands)	-0.0009	-5.10	—	—	—
Constant	-1.60	—	—	—	—
$R^2 = 0.97$					
Percentage reporting C1 or C2					
C2 Last Year	1.63	7.07	32%	—	—
Mission O&S (FY98 $M)	-0.0004	-0.10	—	—	—
Active personnel (thousands)	0.0002	0.85	—	—	—
Constant	-0.07	—	—	—	—
$R^2 = 0.25$					

Table VI-6. Regression Results for Spending and Force Size (O&M)

	Coefficient	*t*-value	Carry-over from Last Year	Change in Readiness per $1 Billion Change in Mission O&M	Long-term Impact of $1 Billion Change
Percentage reporting C1					
Last year (%)	3.82	29.57	86%	—	—
Mission O&M (FY98 $M)	0.01	4.31	—	0.33%	2.36%
Active personnel (thousands)	-0.0003	-3.51	—	—	—
Constant	1.99	—	—	—	—
$R^2 = 0.92$					
Percentage reporting C1 or C2					
Last year (%)	1.20	6.44	23%	—	—
Mission O&M (FY98 $M)	0.03	7.50	—	0.52%	0.68%
Active Personnel (thousands)	-0.0005	-3.51	—	—	—
Constant	-0.07	—	—	—	—
$R^2 = 0.43$					

The regressions show a significant carryover in readiness from the previous year for the percentage reporting C1 (73% for mission O&S and 86% for mission O&M). It is much smaller for the percentage reporting C1 or C2 (only 32% and 23%). This means that once a number of units have achieved C1 status, they are likely to remain at that rating for a time. This could be due to the fact that once a unit has been staffed, equipped, trained and supplied to achieve C1 status, it has learned how to do things right and finds it easier to remain at C1 status than other units that must improve to reach it. The regression on the percentage reporting C1 or C2 using mission O&S as an explanatory variable has a very poor fit and insignificant coefficients on spending and force size.

For the regression using mission O&M, the immediate effect of a $1 billion increase in spending is only 0.3% for the percentage reporting C1 but 0.5% for the percentage reporting C1 or C2. This is about the same size effect we found previously for the percentage reporting C1 or C2. However, the effect for the percentage reporting C1 is much smaller than that from the previous analysis. This indicates that, in the short run, an increase in spending will be used to raise units from C3 or C4 status to C2 more than in raising C2 units to C1 status. This is contrary to what we found in the previous analysis. However, once we look at long-term effects, we saw something else. Because we included the previous year's percentage reporting C1 or percentage reporting C1 or C2 in the equation, we can calculate the long-term impact a permanent $1 billion increase (in FY 1998 dollars) in mission O&M spending would have on readiness. Because of the strong carryover in the percentage reporting C1, a permanent increase in funding will take

longer to have its full effect. However, that full effect will be stronger than if it had a smaller carryover. The long-term increase is shown in the last column of the table. It shows that if the spending increase remains in place, the full impact of the increase on the percentage reporting C1 will be 2.36%. For the percentage reporting C1 or C2, the full impact is only 0.68%.

Those results now agree more closely with what we found previously: in the long run, an increase in spending is used more to raise units to C1 status than to increase the overall percentage of units reporting C1 or C2. It also agrees with our previous finding that the effect of spending on the percentage reporting C1 persists much longer than for the percentage reporting C1 or C2.

C. SUMMARY

There appears to be a relationship between the amount of mission spending and the readiness of forces once differences in force size have been accounted for. The effect of increased spending is stronger on the percentage of units reporting C1 status than on the percentage reporting C1 or C2 status. The effect operates with a lag, particularly for the percentage reporting C1, indicating that it can take some time for the full effect of a change in funding to be felt. The precise nature of the relationships we found may be the result of the high level of readiness that prevailed between 1986 and 1996. If readiness were lower, a more positive impact on the fraction of units reporting in the C2 category might well have been found.

We attempted this analysis for each of the Services, but the results for the individual Services were less consistent than those for all DoD. Despite this, we believe our analysis shows a long-term, quantitative relationship between spending and readiness for DoD.

VII. FINDINGS AND RECOMMENDATIONS

A. FINDINGS

During a period when readiness was widely felt to be adequate it was possible to find consistent relationships between readiness-related funding and force size. This relationship was generally true across the Services and for DoD as a whole for all three categories of O&S spending: mission O&S, mission support O&S, and other O&S. It was also true for what we termed discretionary mission O&M spending (mission O&S spending minus military personnel costs and an estimate of civilian personnel costs).

Mission O&S spending had the strongest relationship to force size. It varied in rough proportion to force size, with the exception of the Marine Corps, where it varied more than in proportion to the number of active personnel.

We found mission support O&S to be consistently related to mission O&S. Across all four Services and for DoD as a whole, a $1 change in mission O&S was estimated to lead to a change of between 33¢ and 43¢ in mission support O&S spending.

Other O&S spending was significantly related to mission O&S for the Army, Navy, Air Force, and DoD as a whole. For the three Services, a $1 change in mission O&S was estimated to lead to a change of between 21¢ and 44¢ in other O&S spending. The estimated effect for DoD as a whole was smaller, probably because other O&S spending by the defense agencies rose as force size fell.

The predictive relationships we developed imply that mission O&S funding during the period from 1975 to 1980 was not adequate to achieve the high levels of readiness achieved after 1984. This finding is consistent with the general view of the previous period as the era of the hollow force.[1]

A comparison of the two periods indicates that mission O&M spending of around $22,500 per active military member maintained high readiness during the latter period.

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1 The Navy relationship is an exception to this finding. We believe that the Navy was able to maintain readiness at lower cost after 1989, and the post-1989 requirement is embodied in our predictive relationship. We do not have a predictive relationship for the pre-1989 period that can be applied to the hollow-force era.

At the all-DoD level, statistically significant relationships can be found between the level of mission-related spending and readiness as reported in SORTS. We examined two models, one of which (the normalized spending model) was based on the analysis of readiness spending presented in Chapter IV. The other model directly related reported readiness to force size and mission spending. Based on the results, we can conservatively estimate that a $1 billion increase in the level of mission-related funding would raise the proportion of combat units reporting C1 readiness status by at least one percent over the long run.

B. RECOMMENDATIONS

The Services and the Office of the Secretary of Defense should begin to use the tools described in this paper to evaluate the level of funding for readiness as part of the program preparation and review process.

Before analyzing programs for the FY 2001 FYDP and beyond, it would be prudent to examine the FY 1998 and FY 1999 programs. After making appropriate corrections for contingency funding, the Services and OSD should determine how much readiness-related funding differed from the levels predicted by our funding-adequacy model. They should observe whether these differences are consistent with the direction of changes in reported readiness. They should also determine how closely changes in the levels of readiness reported in SORTS conformed to estimates developed using the relationships in Chapter VI.

If our predictive relationships do a good job of explaining the FY 1998 and FY 1999 data, they should be used routinely to examine proposed future programs. Programmers and program reviewers must, however, remain wary for the possibility of changes in the relationships due to the adoption of new policies and procedures. Major shifts may invalidate the relationships, which will then have to be re-estimated using new information.

The same kind of analysis we used here should be applied at a less aggregate level. Our tools provide insight into the likelihood of readiness problems at the Service and DoD level, but they do not show where the problems are likely to occur. Readiness-related funding for individual weapon systems and (if possible) units should be linked to readiness at the system or unit level. This could provide valuable guidance concerning where program changes are desirable.

ABBREVIATIONS

DFAS	Defense Finance and Accounting Service
DoD	Department of Defense
EOF	equipment operating factor
FYDP	Future Years Defense Program
IDA	Institute for Defense Analyses
MFP	major force program
O&M	operations and maintenance
O&S	operating and support
OSD	Office of the Secretary of Defense
PE	program element
SORTS	Status of Readiness and Training System
VAMOSC	Visibility and Management of Operating and Support Costs

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13. ABSTRACT ***(Maximum 200 words)***

We developed two tools for analyzing the readiness of proposed future defense programs. The first tool, used for our funding benchmark analysis, compares future readiness funding with past funding in years in which readiness was high, taking changes in force size into account. The second tool, used for our readiness prediction analysis, estimates the effects of proposed readiness funding on future readiness levels. For the funding benchmark analysis, we measured readiness spending and force size and related variations in one to variations in the other. One approach to our readiness prediction analysis drew on the benchmarking analysis; another approach directly related SORTS ratings to mission-related readiness spending and force size. We found that mission-related spending varied in rough proportion to force size during the high-readiness period of 1984–97; mission-support and other spending were not quite as sensitive to changes in force size; readiness spending during the "hollow-force period" of 1975–80 was far below the levels after 1984; and force readiness is significantly related to mission-related spending.

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